APPENDIX D
Model Simulations

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INTRODUCTION

The Lower Kissimmee Basin Groundwater Model includes all of Okeechobee and Highlands counties and most of Glades County. It also includes portions of Polk, Osceola, Indian River, St Lucie, Martin, Palm Beach, Charlotte, De Soto and Hardee counties (see **Figure D-1**). The Lower Kissimmee Basin Groundwater Model (Radin 2005) is a four-layer, steady-state model, using the USGS MODFLOW application (Harbaugh, A.W. and M.G. McDonald 1996). The model was developed as a revision to the Glades, Okeechobee and Highlands Model developed for the 2000 Kissimmee Water Supply Plan. The new model revisits the hydrostratigraphy data in the Lower Kissimmee Basin as a result of the recent investigations conducted in south Florida. The hydrostratigraphy in the model region is still sparse, however, and there are no data points in the Lower Floridan Aquifer.

The model was developed to provide support for the South Florida Water Management District (SFWMD) 2005 Kissimmee Basin Water Supply Plan Update. The model will be used to evaluate the effects of projected increases in groundwater withdrawals from the Upper and Middle Floridan aquifers. The model was calibrated using water use estimates from 1995. The calibration took place using the following criteria:

- In the Surficial Aquifer System, the simulated heads are to be within 4 feet of the observed heads.
- In the Upper and Middle Floridan aquifers, the simulated heads are to be within 2.5 feet of the levels in the Average 1995 Upper Floridan Potentiometric Surfaces Map. The Average 1995 Potentiometric Map was calculated using Knowles September 1995 and May 1995 maps as starting points.
- The calibrated model produced simulated water levels that met the calibration criteria.

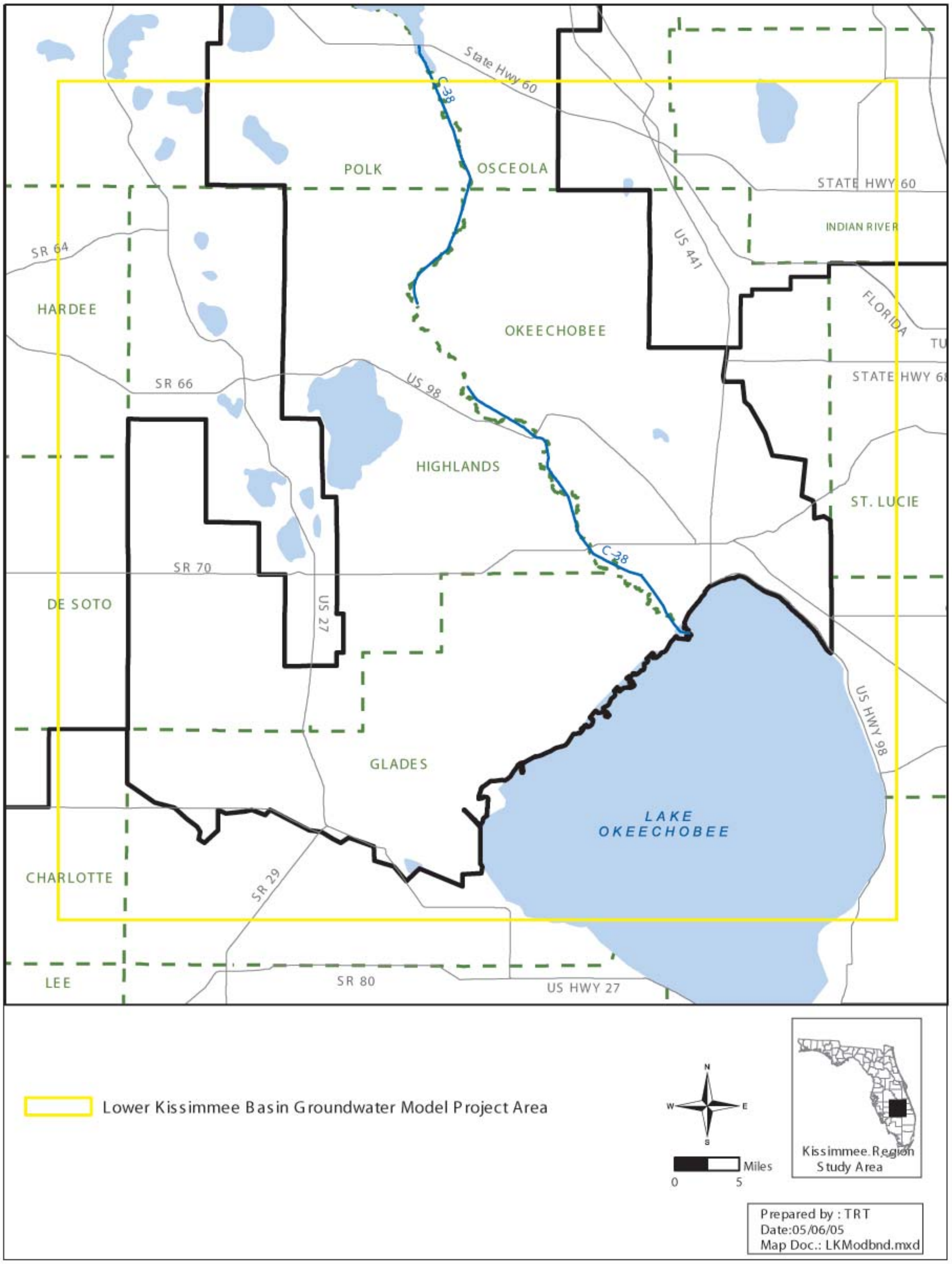

Figure D-1. Lower Kissimmee Basin Groundwater Model.

Purpose

A model is a tool used to represent an approximation of the field data to assist in understanding the groundwater flow system. This model is a steady-state model, and therefore, represents a state of equilibrium under averaged stress conditions. In reality, the stresses would vary with time. The model also uses average values for the hydrologic properties and stresses for each cell in the model grid. Despite these limitations, the model is a valuable tool to assess the behavior of the groundwater system under varying conditions, both climatic and consumption, such as a 1-in-10 year drought, or changes in water consumption due to population growth or changes in agricultural use.

Scope

The model is a tool for projecting water needs for the Kissimmee Basin Water Supply Plan. One objective of the model is to analyze the impact of wellfields proposed by the Heartland Water Alliance (**Figure D-2**). The Heartland Water Alliance is looking for sources of public water supply for the future needs (2025) of Polk, Hardee, DeSoto and Highlands counties. Three of the proposed wellfields – G62, G63 and G64, fall within the Lower Kissimmee Basin Groundwater Model boundaries. The remaining proposed projects are outside of the SFWMD boundaries, and are located in the Southwest Florida Water Management District (SWFWMD) area. Each of these proposed wellfields were modeled as withdrawals from the Upper Floridan Aquifer (Layer 2, see **Table D-1**). In each of these modeled scenarios, there are existing Middle Floridan Aquifer wells located in the same cell, or in at a distance of one or two cells (**Figure D-3**).

Table D-1. Assumptions on Wellfields.

Well	Layer	Row	Column	MGD*	Ft^3/day
G62	2	73	12	2.00	267,400.00
G63	2	34	38	2.00	267,400.00
G64	2	77	55	5.00	668,500.00

* Million Gallons per Day

Each of these wellfields was simulated in the model one at a time. Local impacts were observed and are detailed in this document. Due to the proximity of these wells to the SWFWMD boundaries, impacts were seen in SWFWMD areas as well. This document makes no claim as how to the SWFWMD perceives these impacts.

The Lower Kissimmee Basin Groundwater Model simulated 12 scenarios (runs). Each run was based on 1995 climatic conditions, 1995 1-in-10 rain conditions or 2025 1-in-10 conditions. The impact of the wellfields was simulated with these runs.

Three alternative scenarios were run placing the proposed wellfields in Layer 3 – the Middle Floridan Aquifer. These runs simulated the effects of all three wellfields at once. The runs were conducted for 1995 climatic conditions, 1995 1-in-10 rain conditions or 2025 1-in-10 conditions.

Two runs were conducted with wells turned off to evaluate the impact of the changing land use between 1995 and 2025; both of these assumed 1-in-10 climatic conditions.

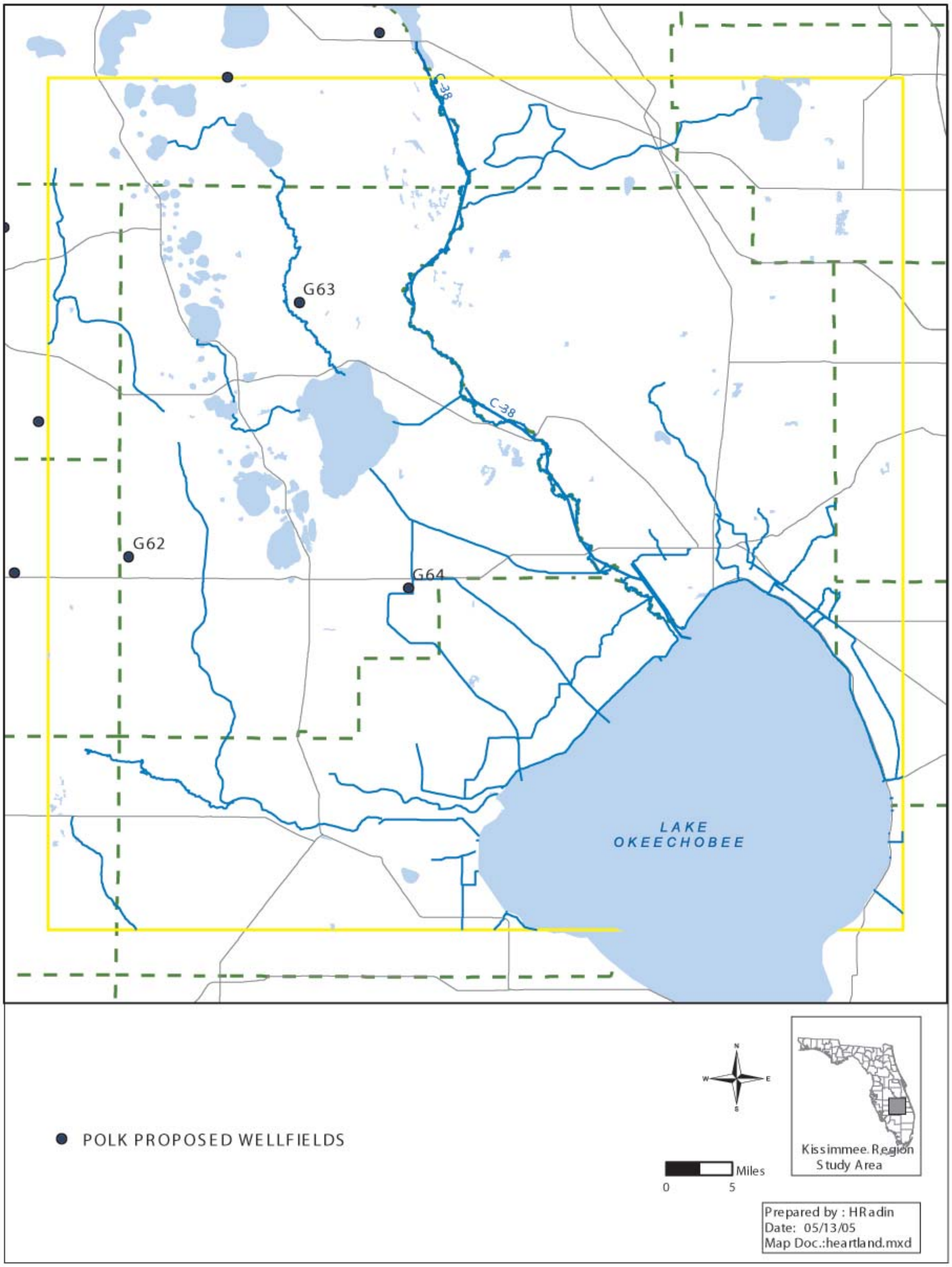

Figure D-2. Proposed Wellfields from Heartland Water Alliance.

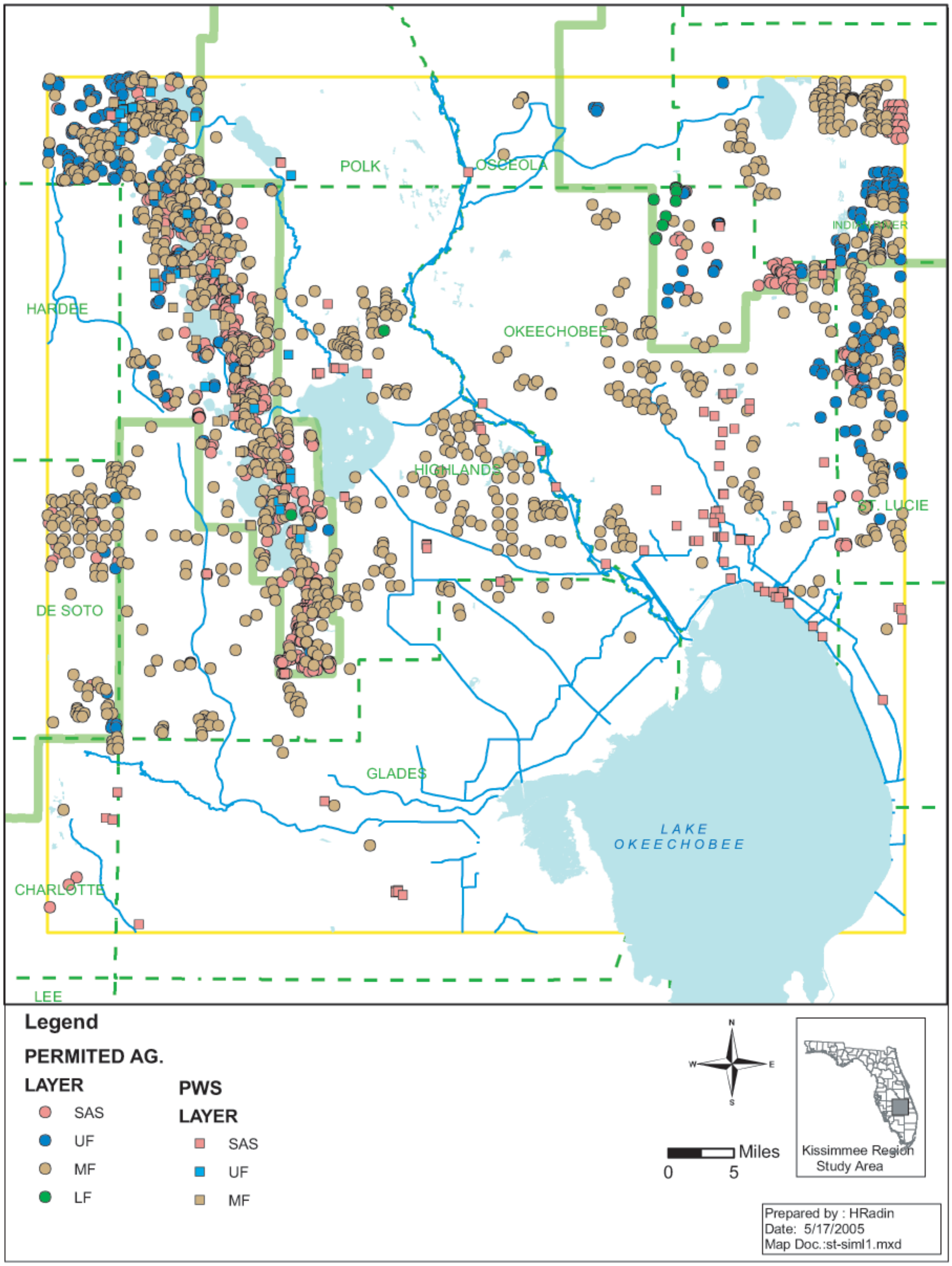

Figure D-3. Consumptive Use Wells.

General Features of MODFLOW

Once modeling objectives have been established, and a preliminary understanding of the predominant hydrologic processes within the area of interest has been attained, a model code, which can meet the model development and application objectives, is selected. MODFLOW, a code created by the U.S. Geological Survey (USGS), was selected for this purpose because the code:

- Has been widely accepted in the groundwater modeling profession for over 15 years.
- Is well documented and within the public domain.
- Is readily adaptable to a variety of groundwater flow systems.
- Is modular and easily facilitates any modifications required to enable its application to the types of unique groundwater flow problems encountered in south Florida.

MODFLOW, a three-dimensional finite difference groundwater flow program, was developed by McDonald and Harbaugh of the USGS in 1984, and a revised version was published in 1988. Additional features were added to in 1996, and that version was named MODFLOW96 (Harbaugh and McDonald. 1996).

The SFWMD has modified some of USGS modules to allow for additional functionality. MODFLOW96 simulates groundwater flow in both the anisotropic and heterogeneous layered aquifer systems using a finite-difference “block centered” approach. The SFWMD version of MODFLOW96 enhanced the Well Package to allow for multiple well files.

MODFLOW with District Source Code

MODFLOW simulates groundwater flow in aquifer systems using the finite-difference method. The aquifer system is divided into rectangular or quasi-rectangular blocks by a grid (**Figure D-4**). The grid of blocks is organized by rows, columns and layers, and each block is commonly called a cell.

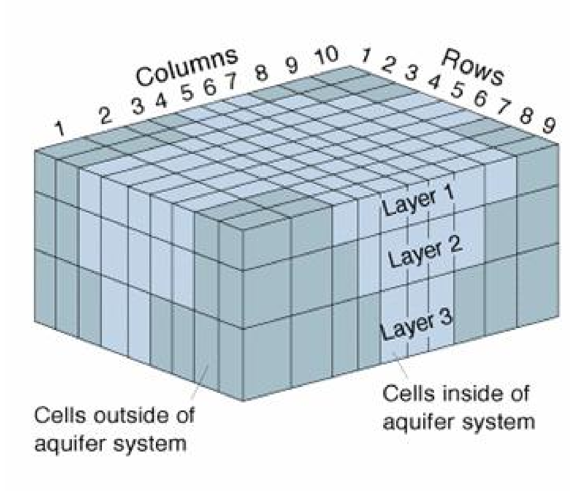

Figure D-4. Example of Model Grid for Simulating 3-Dimensional Groundwater Flow.

For each cell within the aquifer system, the user must specify aquifer properties. Also, the user specifies information relating to wells, canals and other hydrologic features for the cells corresponding to the locations of the features. For example, if the interaction between a canal and an aquifer system is simulated, then for each cell traversed by the canal, the required input information includes layer, row and column indices; canal stage; and hydraulic properties of the channel bed. Also, MODFLOW allows the user to specify which cells within the grid are part of the groundwater flow system and which cells are inactive (i.e., outside of the groundwater flow system).

The MODFLOW model code consists of a main program and a series of independent subroutines called modules. The modules, in turn, have been grouped into packages, which each deal with a particular hydrologic process or solution algorithm. The packages used for Lower Kissimmee Basin Groundwater Model simulations, including those developed or enhanced by SFWMD staff and contractors, are shown in **Table D-2**.

Table D-2. MODFLOW96 Packages Used in the Model.

Package	Description	Notes
Core		
Basic and Output Control	Defines stress periods, time steps, starting heads, grid specifications, units and output specifications	Handles the primary administrative tasks associated with a simulation
Block-Centered Flow (BCF)	Specifies steady-state vs. transient flag, cell sizes, anisotropy, layer types and hydrogeologic data for each layer	Derived primarily from geologic data used to construct the model
Surface Water Stresses and Processes		
Recharge	Simulates areally distributed recharge to a water table during each stress period	Preprocessed using an Agricultural Field-Scale Irrigation Requirements Simulation (AFSIRS) based ET- Recharge Model
Evapotranspiration (ET)	Simulates removal of water from the water table via transpiration and direct evaporation	Preprocessed using an AFSIRS based ET-Recharge Model; ET rate diminishes with increasing water table depth
River (RIV)	Simulates groundwater interchanges with canals that can either recharge or drain the aquifer	Canal stages are usually based on measured stages or control elevations
Drain (DRN)	Essentially the same as the River package, except canals can only drain the aquifer and water removed by the drains is removed permanently from the model	Canal stages are usually based on weir elevations
Water Supply and Management		
Well	Simulates withdrawals from wells	Includes Public Water Supply (PWS) and irrigation wells (Ag); enhanced by the SFWMD to read multiple input files
Solution Algorithms		
Strongly Implicit Procedure (SIP)	A mathematical solution algorithm internal to the model	Enhanced by District to improve model stability

Conceptual Model

In order to simulate the groundwater flow in the model domain, the hydrogeologic framework needed to be simplified for modeling purposes. The conceptual model consists of four aquifers separated by three semi-confining units and underlain by a confining unit. The flow in the aquifers is represented as purely horizontal flow, while the flow through the semi-confining units is only vertical. This gives a quasi three-dimensional model. Vertical flow from Layer 1 to Layer 2 (or Layer 2 to Layer 1), Layer 2 to Layer 3 and Layer 3 to Layer 4 occurs via the semi-confining units (See Vertical Discretization of Model Layers in **Figure D-5**).

Model Design

The model domain for the Lower Kissimmee Basin Groundwater Model is described as follows:

Table D-3. Model Domain for the Lower Kissimmee Basin Groundwater Model.

In Decimal Degrees	In Projected Florida East NAD83 HARN Feet
West Corner: -81.654709	Left Corner: 444435.531250
East Corner: -80.593469	Right Corner: 787635.531250
North Corner: 27.764485	Top Corner: 1247082.062500
South Corner: 26.818899	Bottom Corner: 903882.062500

The Lower Kissimmee Basin Groundwater Model projects in the following coordinate system: NAD 1983 State Plane Florida East FIPS 0901 Feet. The geographic coordinate system name is GCS North American 1983.

The Lower Kissimmee Basin Groundwater Model is composed of a grid containing 130 rows and 130 columns. Each cell is 2,640 feet x 2,640 feet. Lake Okeechobee, Lake Istokpoga and the model cells southeast of the lake are inactive.

The Lower Kissimmee Basin Groundwater Model consists of four layers. The top layer represents the unconfined Surficial Aquifer System, the next layer represents the Upper Floridan Aquifer, the third layer is the Middle Floridan Aquifer and the bottom layer is the Lower Floridan Aquifer. The Intermediate Confining Unit/Aquifer and the Middle Confining Unit 1 and 2 are represented as vertical conductance values between the aquifer layers. (See Vertical Discretization of Model Layers in **Figure D-5**.)

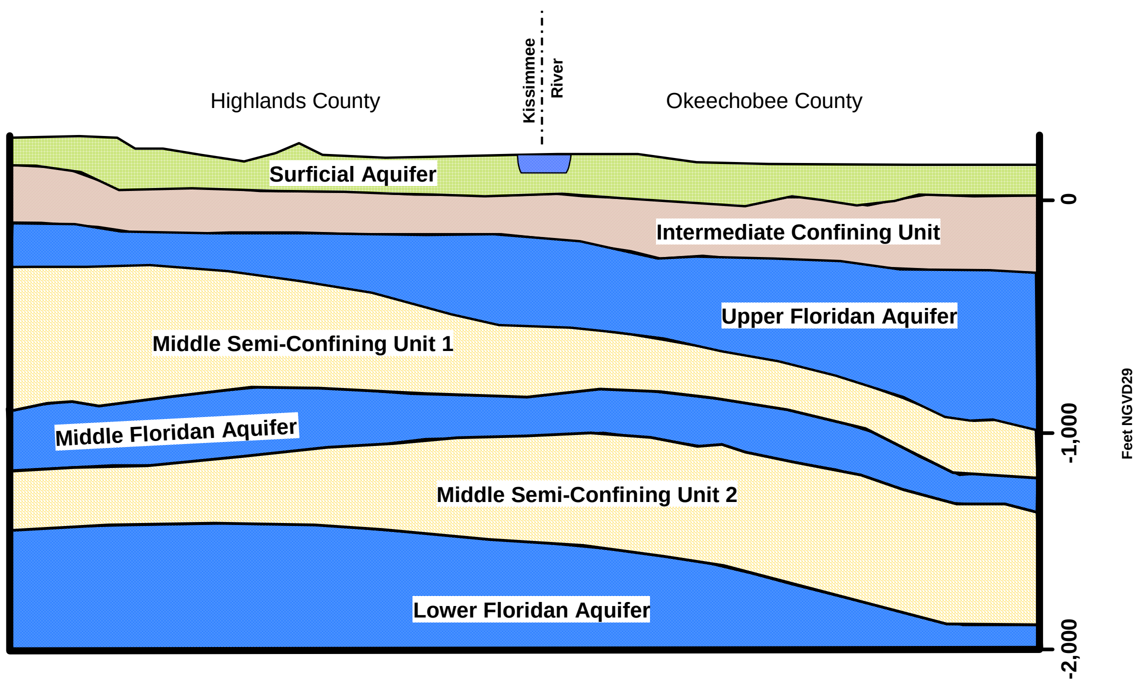

Figure D-5. Vertical Discretization of Model Layers.

Surface water features are modeled in Lower Kissimmee Basin Groundwater Model. A discussion of these features, such as rivers, canals and drains, can be found in the model documentation (Radin 2005)

Model Calibration

The calibration run of this model simulates average 1995 steady state conditions. The base run simulates 1995 1-in-10 rainfall conditions. The 1-in-10 rainfall conditions or a 1-in-10 year drought event is defined as an event with a return frequency of once in 10 years. The model is used to evaluate projected 1-in-10 rainfall conditions for 2025.

PREDICTIVE SIMULATIONS

For the model simulations, the consumptive agricultural use was calculated based on land use, irrigated acreage, crops and climatic conditions instead of on permit allocations, which were used for the initial calibration of the original model. Since agricultural water use is not metered, basing the water consumption on the permits alone was not considered to be accurate enough for modeling purposes.

The groundwater model is being used as a tool to evaluate the impact of 1-in-10 year drought conditions as part of the criteria, which were identified as Resource Protection Constraints for water supply planning purposes. A 1-in-10 year drought condition is defined as below normal rainfall with a 90 percent probability of being exceeded over a 12-month period. This means there is a 10 percent chance than less than this amount will be received in any year.

Gamma distribution was used to determine monthly and annual 1-in-10 rainfall amounts for the period of January 1965 through December 2000. Gamma distribution is a statistical function using study variables, which may have a skewed distribution. The gamma distribution is commonly used in queuing analysis. The values for the statistical 1-in-10 rainfalls are shown in **Table D-4**, which presents the gamma 1-in-10 statistics for each of the 12 months, the sum of the 12 months and the annual 1-in-10 statistics. The annual gamma 1-in-10 statistic is higher than the sum of the monthly 1-in-10 rainfall months. For the model, the data for actual months and years were selected by proximity of the actual monthly rainfall to the 1-in-10 statistic. **Table D-5** shows the actual years and rainfall values used in the model. For example, the 1-in-10 rainfall for Avon Park in January was 0.32 inches and the actual dataset for January 1974 was 0.38 inches. That month's rainfall was closet to the statistical 1-in-10 value. The daily values for January 1974 from Avon Park were used to calculate irrigation demands.

Table D-4. Statistical 1-in-10 Rainfall (in inches) for Seven Rainfall Stations.

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum	Annual
Avon Park	0.32	0.56	0.74	0.32	1.32	3.35	4.71	3.92	3.00	0.80	0.24	0.45	19.73	40.94
Archbold	0.31	0.56	0.74	0.34	1.44	3.34	4.73	3.89	3.04	0.84	0.25	0.44	19.92	40.93
Belle Glade	0.63	0.60	0.82	0.48	1.56	3.79	4.50	3.57	4.13	1.72	0.59	0.40	22.79	48.85
Fort Drum	0.41	0.74	0.54	0.40	0.71	3.39	4.00	3.70	2.75	0.93	0.59	0.39	18.55	40.49
LaBelle	0.35	0.59	0.65	0.23	1.38	4.91	4.44	5.17	3.40	0.83	0.25	0.20	22.40	42.74
Moore Haven	0.26	0.46	0.50	0.26	0.97	2.96	2.99	2.75	2.23	0.70	0.16	0.24	14.48	36.97
Okeecho bee	0.38	0.56	0.70	0.46	0.84	2.70	3.78	3.32	3.35	1.25	0.36	0.45	18.15	35.47

Note: Based on Gamma Distribution.

Table D-5. Actual Rainfall/Months with Values Close to 1-in-10 Rain Values.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum of Rain in 1-in-10 months (in.)	Statistical 1-in-10 Rain/ Station (in.)
Avon Park	Year	1974	1976	1966	1977	1992	1990	1980	1996	1974	1997	1996	1981		
	Sum of Rain in inches	0.38	0.54	0.77	0.26	1.24	3.22	4.60	4.03	3.22	0.76	0.24	0.55	19.81	40.94
Archbold	Year	1974	1977	1999	1978	1993	1987	1977	1970	1988	1979	2000	2000		
	Sum of Rain in inches	0.33	0.53	0.76	0.43	1.33	3.27	4.68	4.24	2.41	0.96	0.24	0.38	19.56	40.93
Belle Glade	Year	1968	1995	1967	1973	2000	1977	1969	1965	1973	1981	1990	1975		
	Sum of Rain in inches	0.69	1.11	0.87	0.56	1.56	3.78	4.48	3.58	4.93	1.94	0.68	0.28	22.79	48.85
Fort Drum	Year	1965	1997	1977	1987	1967	2000	1999	1979	1980	1977	1965	1966		
	Sum of Rain in inches	0.38	0.75	0.53	0.38	0.47	3.27	4.02	3.80	2.92	0.84	0.69	0.39	18.44	40.50
Labelle	Year	1984	1985	1974	1986	1992	1976	1972	1983	1990	1978	2000	1996		
	Sum of Rain in inches	0.47	0.61	0.70	0.27	1.35	4.68	4.56	4.62	3.39	0.84	0.26	0.19	21.95	42.75
Moore Haven	Year	1971	1971	1966	1986	1965	1988	1998	1965	1990	1988	1970	1968		
	Sum of Rain in inches	0.25	0.51	0.42	0.24	1.11	2.87	2.86	2.78	2.77	0.80	0.13	0.21	14.95	37.00
Okeechobee	Year	1965	1999	1977	1971	1965	1981	1982	1999	1977	1975	1995	1990		
	Sum of Rain in inches	0.34	0.56	0.69	0.48	0.84	2.70	3.94	3.46	3.08	1.16	0.41	0.48	18.14	35.50

The model estimated average reference evapotranspiration values for each day of years 1965–2000. The average evapotranspiration values were used with the 1-in-10 rainfall to predict the irrigation demands with the AFSIRS program (Giddings and Restrepo 1995).

The same stations were used for both 1-in-10 rainfall and for the reference evapotranspiration, since both theses datasets required 36 years of data.

The same climatic conditions were simulated with two sets of stresses: consumption based on 1995 land use and consumption based on the future land use. For future simulations, an assumption was made that public water supply demands for the SWFWMD would remain the same. Only public water supply changes within the SFWMD were simulated. The main difference between the 1995 and 2025 1-in-10 simulations was the agricultural consumption, which varies based on land use changes. For these calculations, water use was not assigned to areas with a land use designation of unimproved pasture. For all other land uses, the irrigation crop demand based on AFSIRS was applied to the permitted areas.

Estimates of agricultural demands were also modified from the 1995 calibration run. Recharge, evapotranspiration and irrigation time series demands were computed using the ET-Recharge Model (Restrepo and Giddings 1994). This is an extension of the Agricultural Field Scale Irrigation Requirements Simulation (AFSIRS) Program, which estimates irrigation demands on a daily basis for a specific crop and acreage due to soil, rainfall, evapotranspiration and other parameters (Smajstrla 1990). Irrigation demands for each cell are determined by combining the GIS coverages for the land use, permitted areas, soil coverage, evapotranspiration and rainfall stations. The irrigation demand is then calculated for each individual polygon, and composite irrigation for each cell of the model is ultimately developed. This approach tends to result in a more accurate seasonal representation of the irrigation demands, but the overall annual demand is not significantly different than that calculated using the Blaney-Criddle Method, which was used in the original 1995 calibration run.

The Future Land Use/Land Cover

Future land use (2025, see **Figure D-6**) was developed by a technical team at the SFWMD using the following general procedure:

The base coverage for the future land use update is the 2000 land use update for the desired area. The future land use data were gathered by contacting planning departments for each county in the model. In some cases, it was necessary to contact individual city planning department to gather data. County Web sites were often a good place to begin gathering information. The gathered data were analyzed and quality checked. All data were converted into coverages for processing. Missing data were added. This future land use coverage was developed for incorporation into the South Florida Water Management Model (SFWMM) as a 2050 future land use layer (without project). The coverage is based on the recently updated 2000 land use and the most recent comprehensive plans (future land use coverage) from each county. Since the comprehensive plan maps from the counties show only land use and the SFWMM requires land cover, several assumptions and decisions were made during the generation of the county coverages:

- All areas considered "developable" in 2000 are assigned the future code from the comprehensive plan's future land use coverage. This includes areas under construction, open lands, agricultural land and forests.
- All areas indicated as water in 2000 remain water in the future.
- All wetlands areas in 2000 remain wetlands in the future.
- All agricultural areas in 2000 and anticipated to be agricultural in the future are left unchanged (no change in crop types).
- All areas coded as conservation in the comprehensive plan are assigned the natural land use, which existed at that location.
- In areas that allow for higher densities in the future, the higher density is used.
- Areas owned or pending ownership by the SFWMD are assumed to remain in their natural state and not be infested with exotics, such as Melaleuca and Brazilian Pepper.
- Future land use maps for each county were generated representing conditions roughly around 2020 or 2030.
- Statistical analysis was used to approximate the populations of each county in the future. These numbers were then compared to population estimates from the Bureau of Economic and Business Research (BEBR) and the U.S. Army Corps of Engineers (USACE).

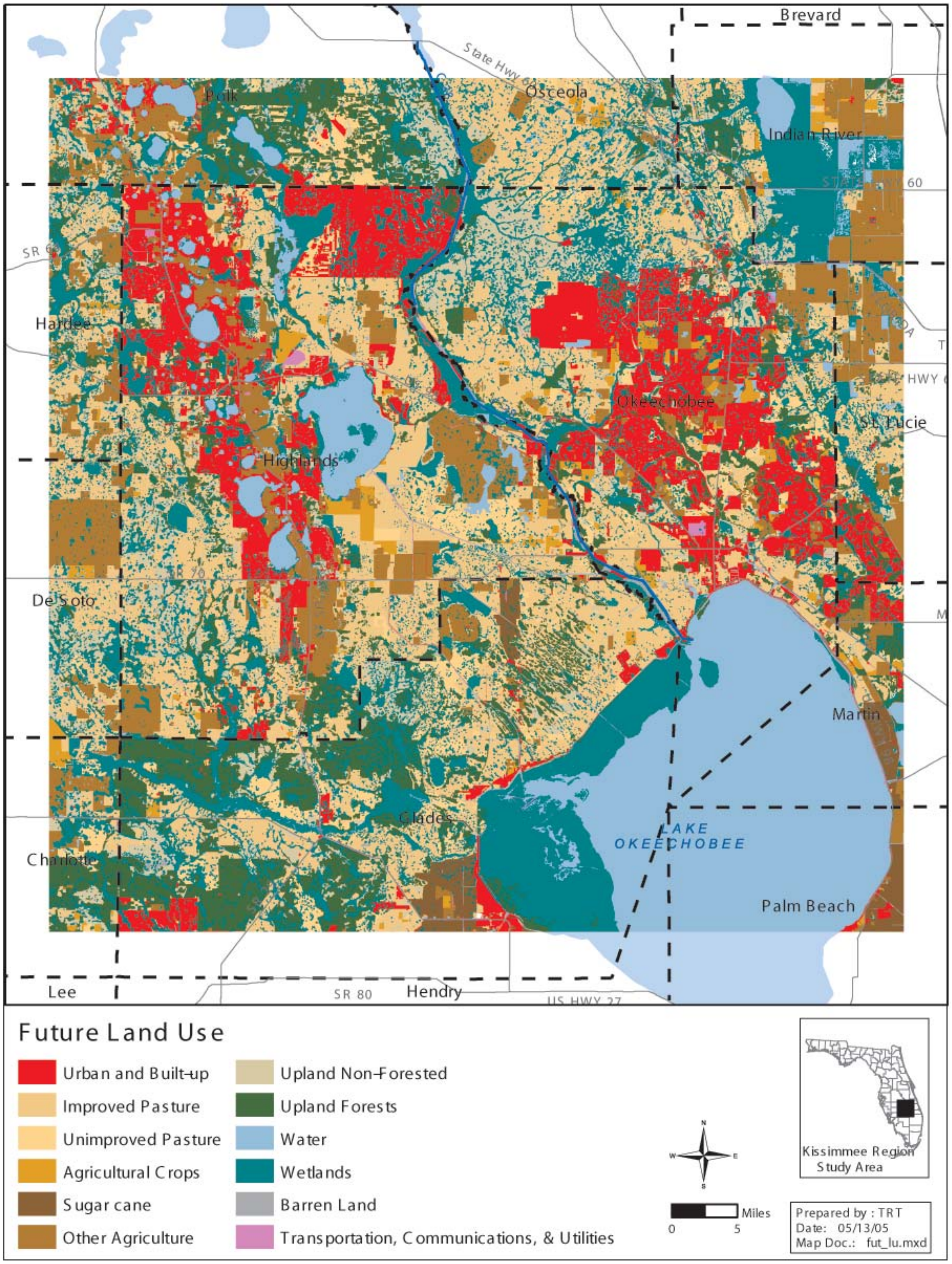

Figure D-6. Future Land Use / Land Cover.

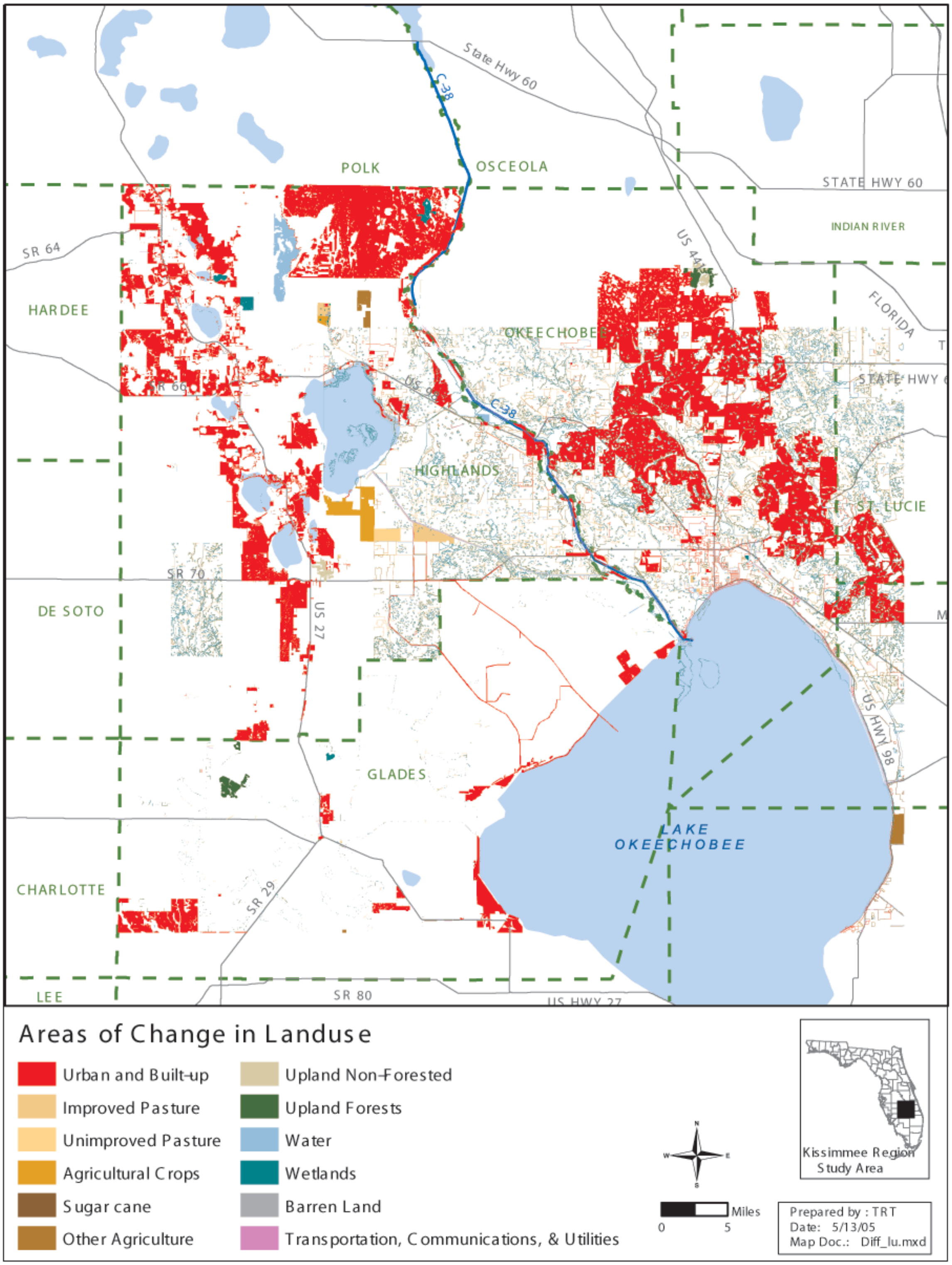

Figure D-7. Areas with Changes in Land Use.

Most of the land use changes (**Figure D-7**) between 2000 and 2025 are the result of conversion of land to urban areas. These changes occur in areas around Lake Wales Ridge, northeastern Polk County and a large portion of Okeechobee County. There are only a few parcels of land that change crop types – mainly converting unimproved pasture to improved pasture or other crops.

Projected Withdrawals

The only modifications made to the predictive simulation runs were changes to the Pubic Water Supply well file within the SFWMD portion of the Lower Kissimmee Basin Groundwater Model to include the proposed new wellfields by the Heartland Water Alliance. In addition, the public water supply demands will change due to projected growth in the population from 2000 and 2025.

The following assumptions were made to create the future public water supply demands:

- Spring Lake District will increase water use from 0.23 MGD to 0.31 MGD.
- Brighton Reservation wells under permit number 22-00183 will increase pumpage from 0.39 MGD to 0.47 MGD.
- Okeechobee Utility Authority used 2.34 MGD in 2000 (0.49 MGD of that from groundwater). They will not use any groundwater in 2025.
- The remaining public water supply wells are not expected to change from 2000 to 2025. No changes were made to wells outside of the SFWMD.
- The agricultural water consumption for 2025 will change with modifications in the land use.

SIMULATION RUNS

Drawdown maps were made to evaluate the changes in water levels between the model runs the unit for all of the figures displaying drawdowns is feet.

All the surface water features remained the same in all the simulated runs.

The following modeling simulations were run:

1. 1995 climatic conditions with agricultural water use assumed from land use (1995 AFSIRS[1] Ag.).
2. 1995 AFSIRS Ag and well G62.
3. 1995 AFSIRS Ag and well G63.
4. 1995 AFSIRS Ag and well G64.
5. 1995 land use, and AFSIRS agriculture well file, under 1-in-10 rainfall conditions – i.e. Drought conditions (1995 1-in-10 simulation).
6. 1995 1-in-10 simulation with well G62.
7. 1995 1-in-10 simulation with well G63.
8. 1995 1-in-10 simulation with well G64.
9. 2025 land use, and AFSIRS agriculture with under 1-in-10 rainfall conditions – i.e. Drought conditions (2025 1-in-10 simulation).
10. 2025 1-in-10 simulation with well G62.
11. 2025 1-in-10 simulation with well G63.
12. 2025 1-in-10 simulation with well G64.
13. 1995 AFSIRS Ag with G62, G63 and G64 in the Middle Floridan.
14. 1995 1-in-10 G62, G63 and G64 in the Middle Floridan.
15. 2025 1-in-10 G62, G63 and G64 in the Middle Floridan.
16. 1995 1-in-10 with wells off.
17. 2025 1-in-10 with wells off.

[1] Agricultural Field Scale Irrigation Requirements Simulation (AFSIRS), by Smajstrla (1990) estimates crop irrigation demands in south Florida.

1995 AFSIRS Agriculture Simulation Run

For this model run, the consumptive use in the agricultural wells was estimated based on AFSIRS calculations for the land use. All the other files were the same as those used for the 1995 calibration run, which were based on the permitted allocations (Radin 2005). The water levels for each model layer from the AFSIRS run were compared to the water levels, which were achieved in the 1995 calibration run using permitted values.

There was not much difference in the simulated water levels at the observation sites between the 1995 run using the permitted agriculture well file and the 1995 run used the agricultural wells based on the land use (see **Table D-6**).

The total agricultural water use estimated from the permits was 248 MGD, while 200 MGD was estimated with AFSIRS based on land use.

Table D-6. Observation Sites Statistics.

Station Name	1995 Hist_Avg	Ag Wells Based on Permits		Ag Wells Based on Land Use	
		Model_Avg	Diff	Model_Avg	Diff
GAC_G	60.79	56.28	4.51	56.27	4.52
TICK ISL_G	48.85	52.34	-3.49	52.34	-3.49
MAXCEY N_G	63.56	62.69	0.87	62.69	0.87
SADDLEBLANKET LAKES NORTH	118.91	111.24	7.67	111.24	7.67
SADDLEBLANKET LAKES WEST	119.86	115.07	4.79	115.98	3.88
SADDLEBLANKET LAKES EAST	121.34	116.51	4.83	117.09	4.25
L.ARBUNK	54.44	53.00	1.44	53.00	1.44
S65A_H	46.33	41.98	4.35	41.98	4.35
S65AX_H	46.40	45.51	0.89	45.51	0.89
IR-25_G	28.48	27.13	1.35	27.15	1.33
LAKE OLIVIA NORTH WEST	116.06	115.14	0.92	115.14	0.92
LAKE OLIVIA NORTH EAST	115.4	115.13	0.27	115.13	0.27
LAKE OLIVIA SOUTH WEST	117.73	115.14	2.59	115.14	2.59
LAKE OLIVIA SOUTH EAST	117.52	115.14	2.38	115.14	2.38
AVON P_G	128.78	114.14	14.64	114.14	14.64
LAKE OLIVIA SOUTH	128.96	126.91	2.05	126.90	2.06
LAKE ISIS NORTH	112.66	112.66	0	112.66	0
LAKE ISIS EAST	110.99	111.22	-0.23	111.35	-0.36
C38.PINE	43.08	44.08	-1.00	44.08	-1.00
LAKE ISIS SOUTH	118.42	118.42	0	118.42	0
LAKE ISIS SOUTH EAST	114.85	114.05	0.80	113.73	1.12
LOTELLA_G	81.38	83.13	-1.75	83.19	-1.81
FTKISS	42.31	41.81	0.50	41.81	0.50
WEIR3_H	42.24	42.37	-0.13	42.37	-0.13
FT DRUM	35.53	34.76	0.77	34.76	0.77
WEIR2_H	41.95	41.84	0.11	41.84	0.11
AVON P3	41.71	40.90	0.81	40.90	0.81
WEIR1_H	41.39	41.39	0	41.39	0
OK-3_G	59.53	61.94	-2.41	61.94	-2.41
SEBRING_G	55.86	58.65	-2.79	58.73	-2.87
ARBUCK.L	40.16	41.98	-1.82	41.98	-1.82
STL-42_G	25.79	25.30	0.49	25.40	0.39
ARBUCK	39.75	39.84	-0.09	39.84	-0.09
H-11A_G	47.95	45.95	2.00	45.95	2.00
BASSETT_G	43.14	45.20	-2.06	45.20	-2.06
S65C_H	33.81	33.48	0.33	33.48	0.33
OK-2_G	44.67	40.96	3.71	40.96	3.71
S68_H	39.12	39.12	0	39.12	0
OPAL_G	33.14	32.37	0.77	32.37	0.77
S65D_H	26.74	26.76	-0.02	26.76	-0.02
YATES M_H	24.37	26.44	-2.07	26.44	-2.07
S82_H	31.87	30.99	0.88	30.99	0.88

Table D-6. Observation Sites Statistics (Continued).

Station Name	1995 Hist_Avg	Ag Wells Based on Permits		Ag Wells Based on Land Use	
		Model_Avg	Diff	Model_Avg	Diff
S83_H	31.97	34.31	-2.34	34.31	-2.34
S84_H	24.71	23.22	1.49	23.22	1.49
S154_H	20.28	19.19	1.09	19.19	1.09
S133_H	13.57	13.57	0	13.57	0
NUBBC_H	19.36	18.98	0.38	18.98	0.38
S75_H	25.78	25.64	0.14	25.64	0.14
S191_H	19.12	19.12	0	19.12	0
S70_H	25.76	25.30	0.46	25.3	0.46
S127_H	13.56	13.56	0	13.56	0
S72_H	20.77	19.18	1.59	19.18	1.59
S135_H	13.60	13.60	0	13.60	0
H-15A_G	58.04	54.62	3.42	54.62	3.42
S71_H	19.92	18.28	1.64	18.28	1.64
S129_H	13.06	13.06	0	13.06	0
S131_H	13.04	13.04	0	13.04	0
FISHP	31.25	30.48	0.77	30.48	0.77
NIOC3	17.99	17.92	0.07	17.92	0.07
NICO1	13.99	12.07	1.92	12.07	1.92
CULV5_H	16.52	16.52	0	16.52	0
S77_H	16.39	16.39	0	16.39	0
OSF-42	43.02	42.92	0.10	43.23	-0.21
ALTMAN DEEP WELL NEAR WEST FR	84.20	83.39	0.81	83.47	0.73
CLENNY DEEP NW/O AVON PK FL	83.05	81.29	1.76	81.99	1.06
OKF-0054	39.08	43.08	-4.00	43.23	-4.15
BONNET LAKE DEEP NEAR SEBRING	83.21	82.38	0.83	81.89	1.32
SMITH DEEP WELL NO. 731136344	71.64	70.29	1.35	70.19	1.45
727100-- 35S33E02 BASS WELL N	46.73	46.73	0	46.80	-0.07
OKF-7	46.19	45.79	0.40	45.85	0.34
OKF-17 DIXIE RANCH	47.00	46.50	0.50	46.42	0.58
OKF-23	44.34	46.75	-2.41	46.27	-1.93
OKF-31_G	49.85	47.34	2.51	47.12	2.73
LAKE PLACID GROVES DEEP SOUTH	51.19	52.16	-0.97	52.18	-0.99
71110501OBSER WELL GL155 NEAR	48.01	47.37	0.64	47.40	0.61
65411601 41S30E12 CLEMONS PAL	49.90	49.51	0.39	49.53	0.37
S-65A(POF-20)WELL NR YEEHAW J	46.30	47.40	-1.10	47.30	-1.00
73911801 33S30E06 USAF AVON P	77.79	75.40	2.39	75.13	2.66
SHEARER DEEP WELL NO 141 NEAR	78.10	78.36	-0.26	78.20	-0.10
OKF-34	46.73	48.00	-1.27	48.07	-1.34
HIF-3 73111501 HOWERTON'S WEL	53.85	54.67	-0.82	54.67	-0.82
CITY SEBRING DEEP 24 AT SEBRI	83.49	82.10	1.39	82.01	1.48
HIF-32 GUILFORD TOMLINSON	53.62	54.46	-0.84	55.15	-1.53

Table D-6. Observation Sites Statistics (Continued).

Station Name	1995 Hist_Avg	Ag Wells Based on Permits		Ag Wells Based on Land Use	
		Model_Avg	Diff	Model_Avg	Diff
HIF-4 34S31E28 YUCAN RANCH NR	49.16	50.98	-1.82	50.78	-1.62
HIF-13_G	47.53	48.50	-0.97	48.60	-1.07
OKF-42	47.1	47.79	-0.69	47.68	-0.58
FTB18	49.23	49.31	-0.08	49.29	-0.06
FTB20	48.52	48.08	0.44	47.85	0.67
FTB17	49.8	48.65	1.15	48.32	1.48
HIF-16_G	61.92	56.80	5.12	56.94	4.98
FTB19	48.92	48.17	0.75	48.22	0.70
HIF-14 P G PHYPERS	49.96	51.46	-1.50	51.41	-1.45
ROMP 28 FLORIDAN WELL NR LAKE	70.13	68.39	1.74	68.37	1.76
FTB45	49.79	48.19	1.60	48.32	1.47
HIF-0037	47.16	47.34	-0.18	47.14	0.02
HIF-8 BOX RANCH	49.08	48.99	0.09	49.20	-0.12
HIF-5 CHARLES STIDHAM	48.87	49.88	-1.01	50.04	-1.17
HIF-23 GRAHAM CO DAIRY	48.68	48.49	0.19	48.50	0.18
HIF-26_G	49.19	49.59	-0.40	49.61	-0.42

For the Surficial Aquifer System, most of the model showed no difference between the run using pumpage based on land use and the pumpage based on the permit database (**Figure D-8**). There were differences of up to 2 feet in the Lake Wales Ridge area, an urban residential area around lakes. The AFSIRS model predicts more consumption for landscape irrigation than is noted from the actual permitted use obtained from SWFWMD permit databases. Other than that area only Nubbin Slough had the AFSIRS model predicting much lower water levels than those with the permitted dataset.

In the Upper Floridan Aquifer, the 1995 AFSIRS simulation predicted more water use around Lake Okeechobee and in citrus areas (**Figure D-9**). The water levels in those areas were up 1.6 feet higher than the water levels simulated with the permitted agricultural consumption. In portions of western St. Lucie County, and near the SFWMD's eastern boundary in Okeechobee County, there was more water consumption based on the AFSIRS than based on the permitted water use. Most of these areas had a difference of less than a foot, but a couple of cells had a difference of up to 8 feet.

The Middle Floridan Aquifer (**Figure D-10**) showed similar areas to the Upper Floridan Aquifer where the AFSIRS predicted less water use than the permitted agricultural consumption run.

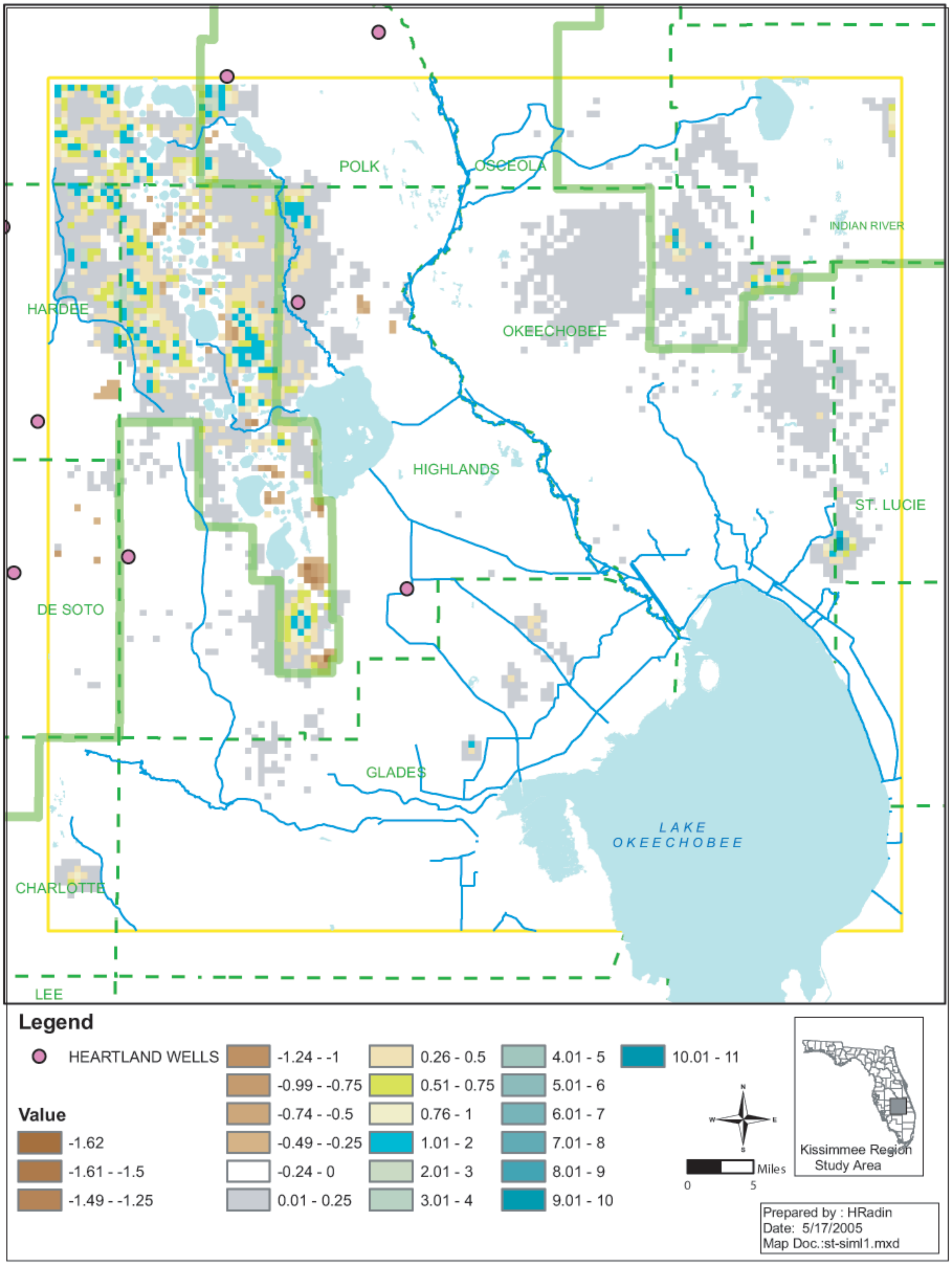

Figure D-8. Difference AFSIRS Ag – Permitted Surficial Aquifer.

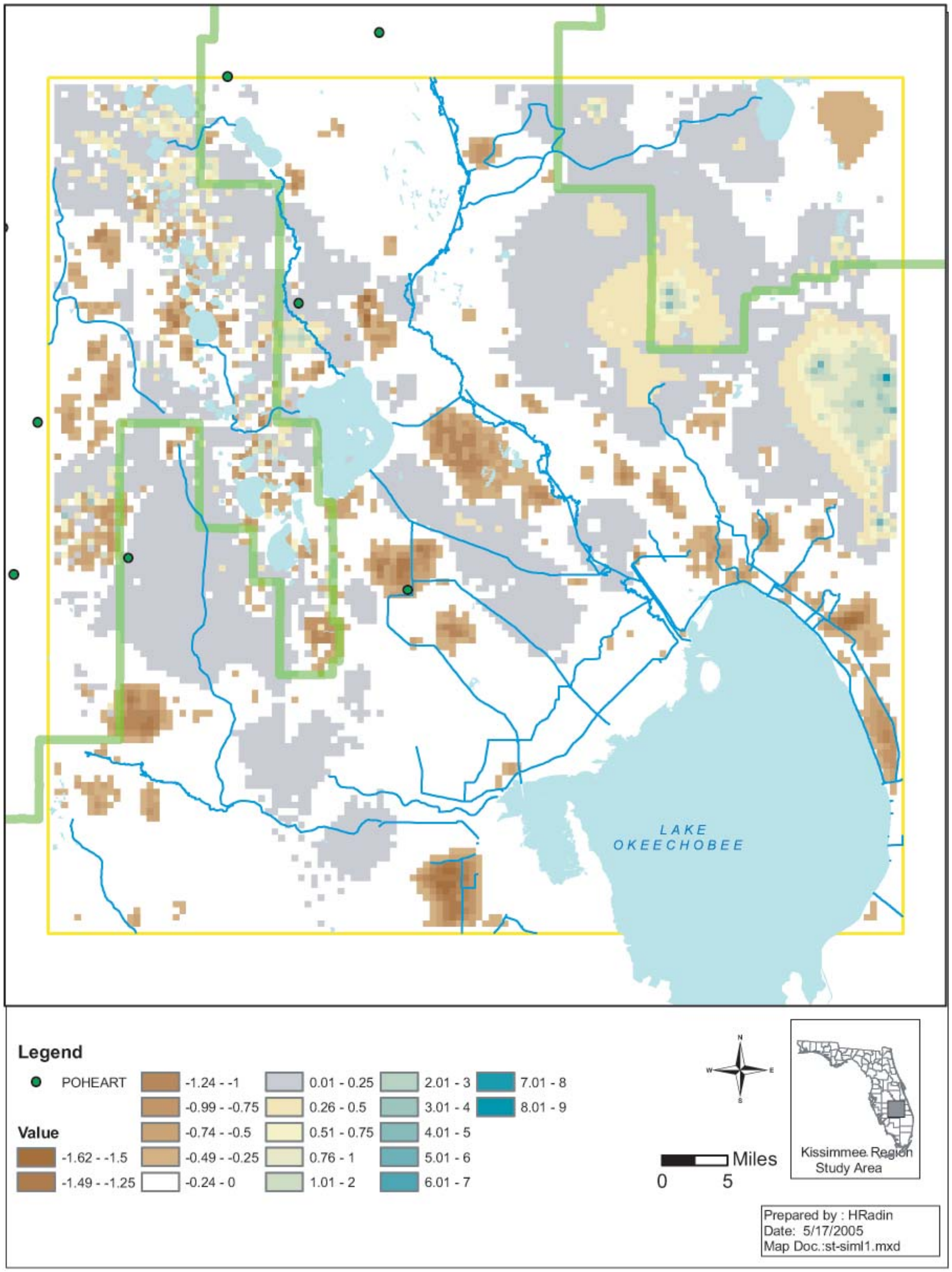

Figure D-9. Difference 1995 AFSIRS Ag – Permitted Upper Floridan Aquifer.

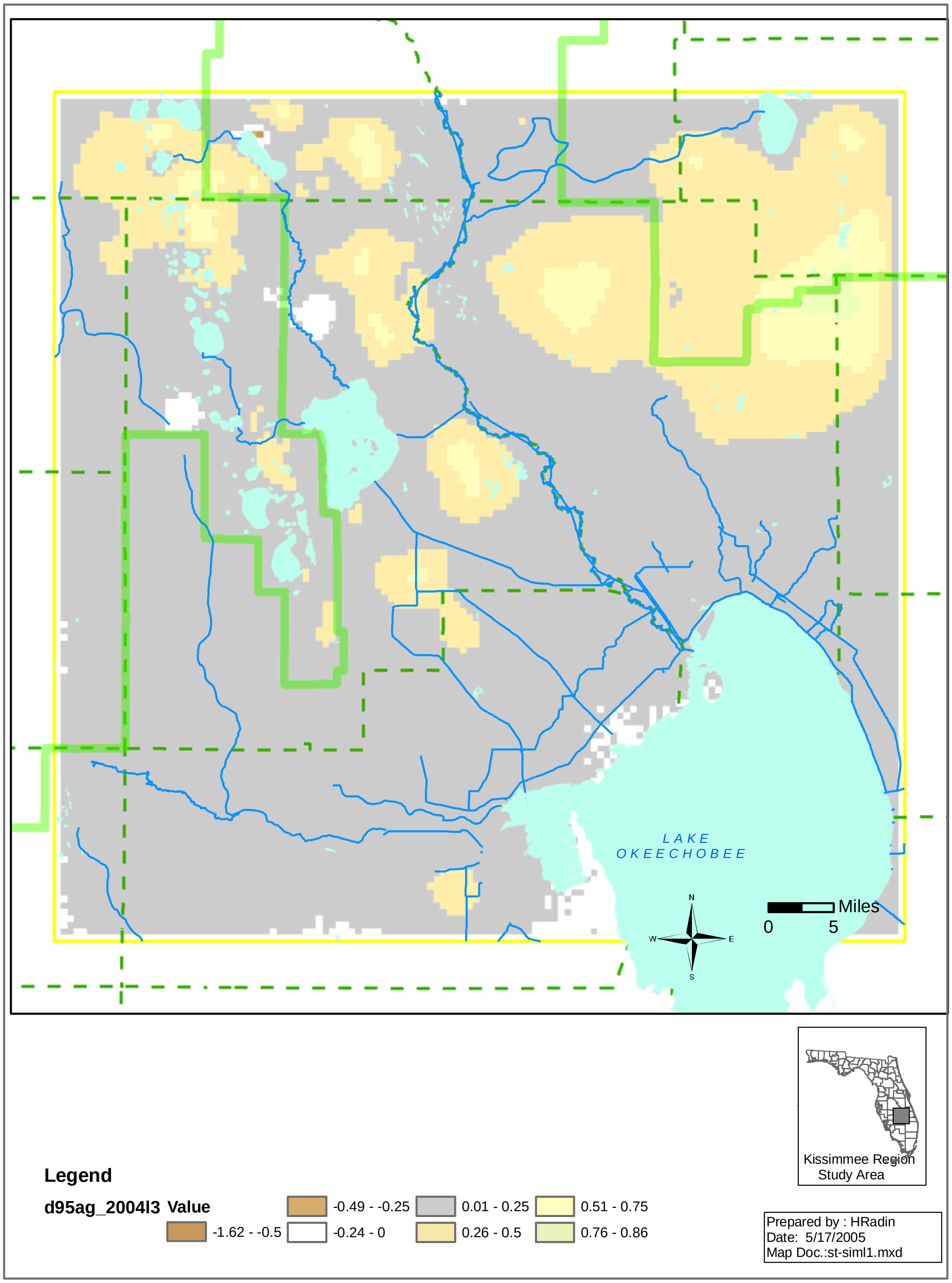

Figure D-10. Difference 1995 AFSIRS Ag – Permitted Middle Floridan Aquifer.

1995 AFSIRS Ag and Well G62

This simulation run uses the same files as the 1995 AFSIRS Ag Run with the addition of one more wellfield – G62 in the Upper Floridan Aquifer. For modeling purposes, the proposed wellfield was placed in Layer 2, Row 73 and Column 12. The model assumes that all the consumption is from one well in the center of the cell. This well was simulated by pumping 2 MGD or 267,400 ft^3/day. The proposed site for G62 places it near the SFWMD/SWFWMD boundary on the Highlands/De Soto county line. The purpose of this simulation is to evaluate the impact of this well on the water levels. This is done by creating drawdown maps, which compare the water levels without well G62 – in this case, the 1995 AFSIRS Ag run – to the water levels with the G62 well.

The local drawdown in the Upper Floridan Aquifer in cell 2, 73 and 12 is 13.31 feet. One cell away (2,640 feet away); the drawdown ranges from 0.5 to 2 feet. A mile away this the drawdown decreases to 0.33 feet. For nearly a 10-mile radius, there is a drawdown of nearly 0.25 feet. Half of the drawdown area falls within the SWFWMD (**Figure D-11**).

No impact was seen in the Surficial Aquifer System – the water levels throughout the model changed by a maximum of 0.01 feet (**Figure D-12**).

The Middle Floridan Aquifer showed a drawdown of up to 0.2 feet with the same drawdown cone “footprint” as in the Upper Floridan Aquifer (**Figure D-13**).

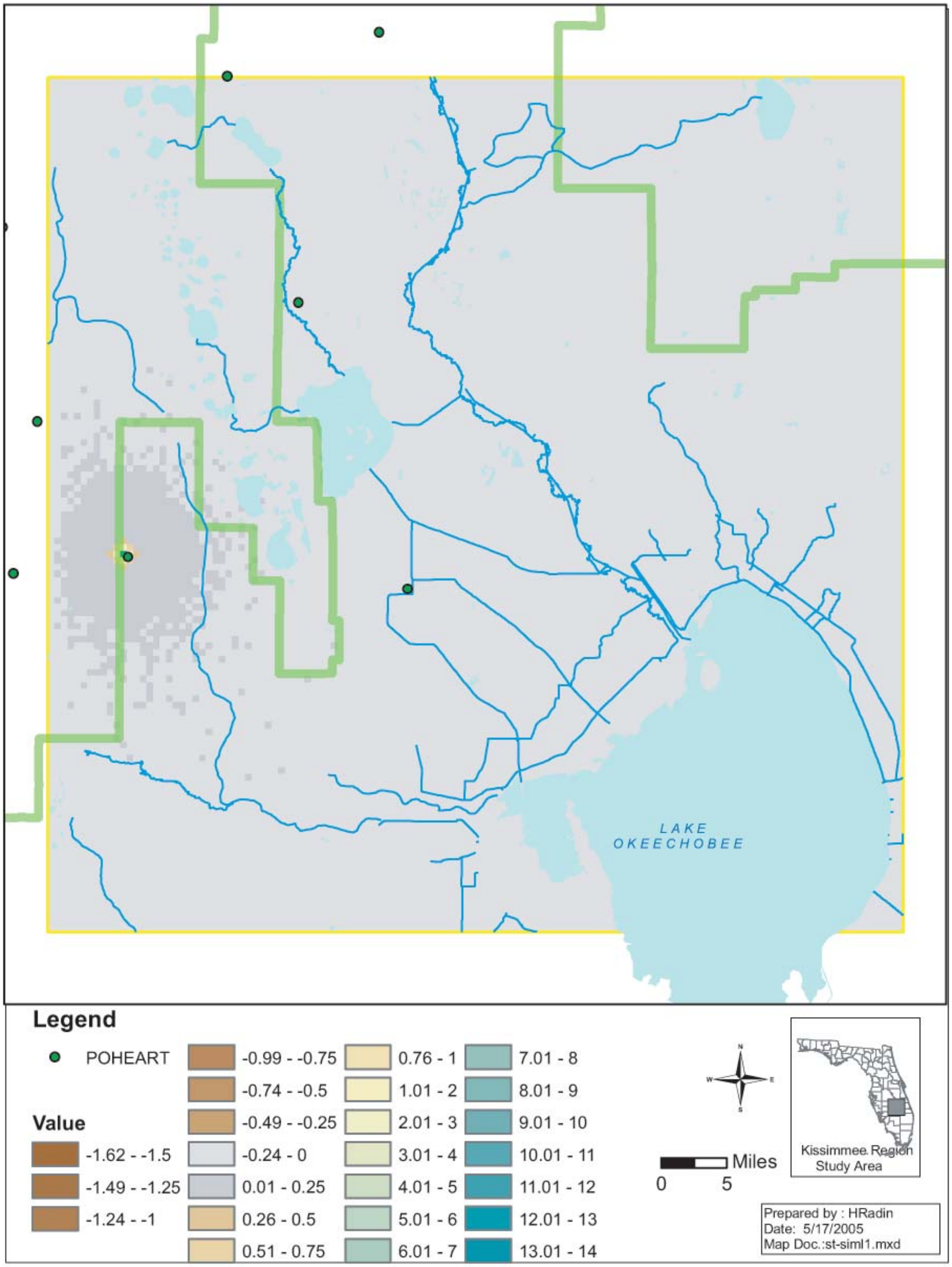

Figure D-11. Difference AFSIRS Ag – G62 Wellfield Upper Floridan Aquifer.

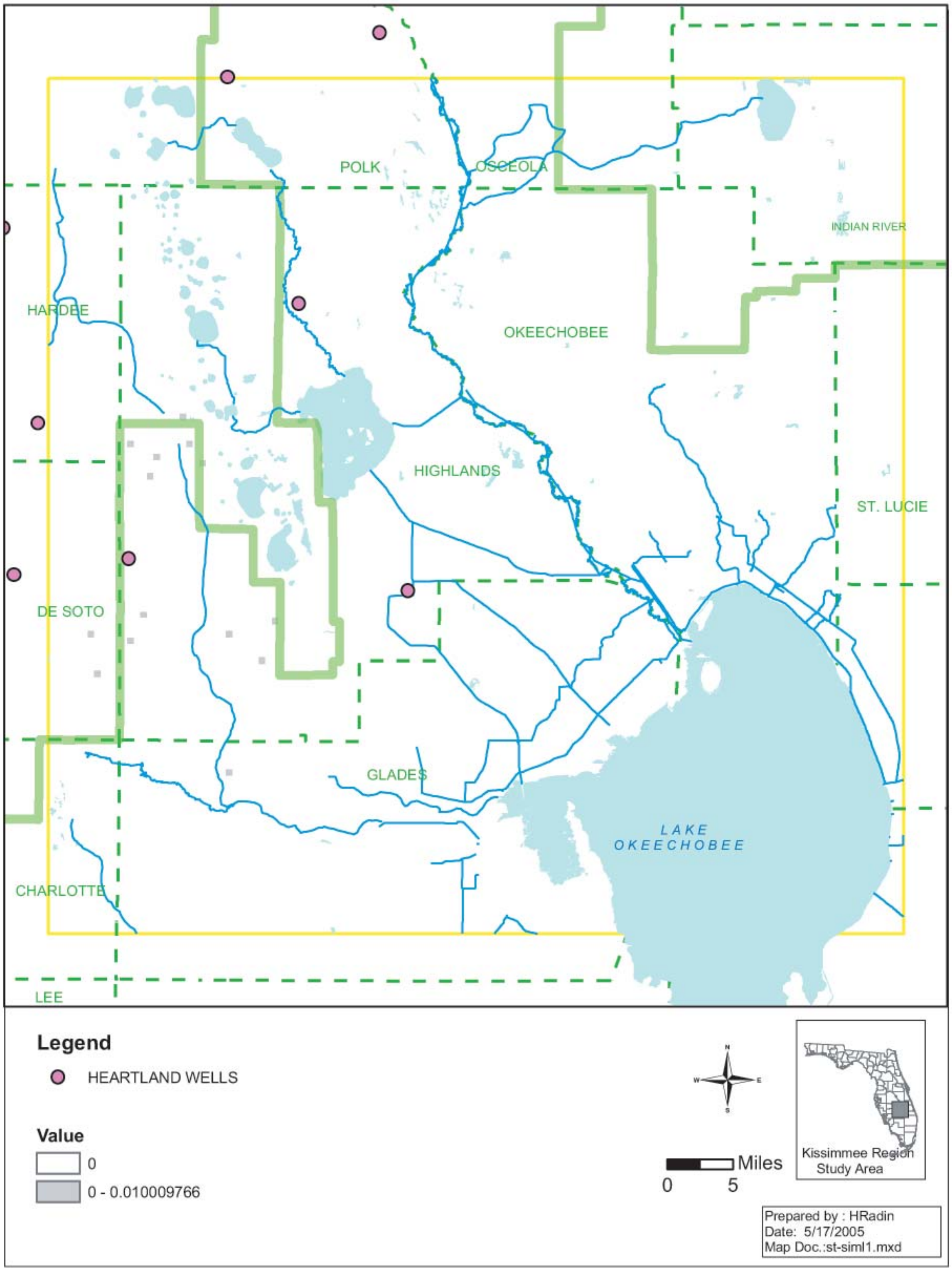

Figure D-12. Difference AFSIRS Ag – G62 Wellfield Surficial Aquifer.

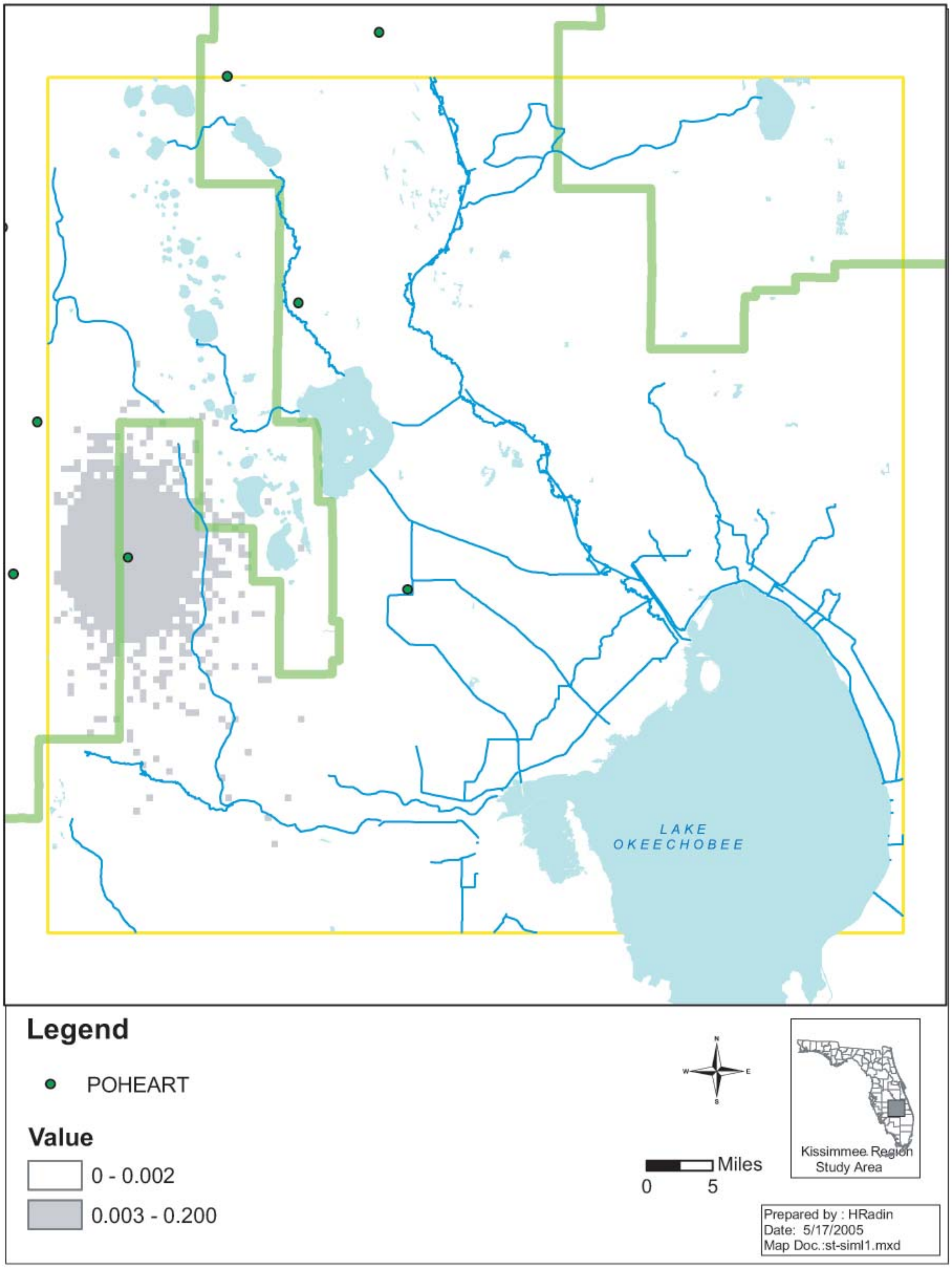

Figure D-13. Difference AFSIRS Ag – G62 Wellfield Middle Floridan Aquifer.

1995 AFSIRS Ag and Well G63

This simulation run uses the same files as the 1995 AFSIRS Ag Run with the addition of one more wellfield – G63 in the Upper Floridan Aquifer. For modeling purposes, the proposed wellfield was placed in Layer 2, Row 34 and Column 38. The model assumes that all the consumption is from one well in the center of the cell. This wellfield was simulated pumping 2 MGD or 267,400 ft^3/day. The proposed site for G63 places it in Highlands County near the SFWMD/SWFWMD boundary near Arbuckle Creek, north of Lake Istokpoga. The purpose of this simulation is to evaluate the impact of this well on the water levels. This is done by creating drawdown maps, which compare the water levels without well G63 – in this case, the 1995 AFSIRS Ag run, to the water levels with the G63 well.

The drawdown in the Upper Floridan Aquifer in cell 2, 34 and 38 is 18.3 feet. One cell away (2,640 feet away); the drawdown ranges from 0.6 to 1.8 feet. A mile away the drawdown decreases to 0.25 feet. For a 5-mile radius around G63, there is a drawdown of about 0.25 feet. This drawdown area extends into the SWFWMD (**Figure D-14**).

No impact from this wellfield was seen in the Surficial Aquifer System – the water levels in four cells east of the wellfield changed by a maximum of 0.04 feet (**Figure D-15**).

The Middle Floridan Aquifer showed a drawdown of up to 2 feet in cell 3, 34 and 38, 0.75 feet one cell over and up to 0.5 feet in an area slightly larger than the drawdown cone “footprint” seen in the Upper Floridan Aquifer (**Figure D-16**).

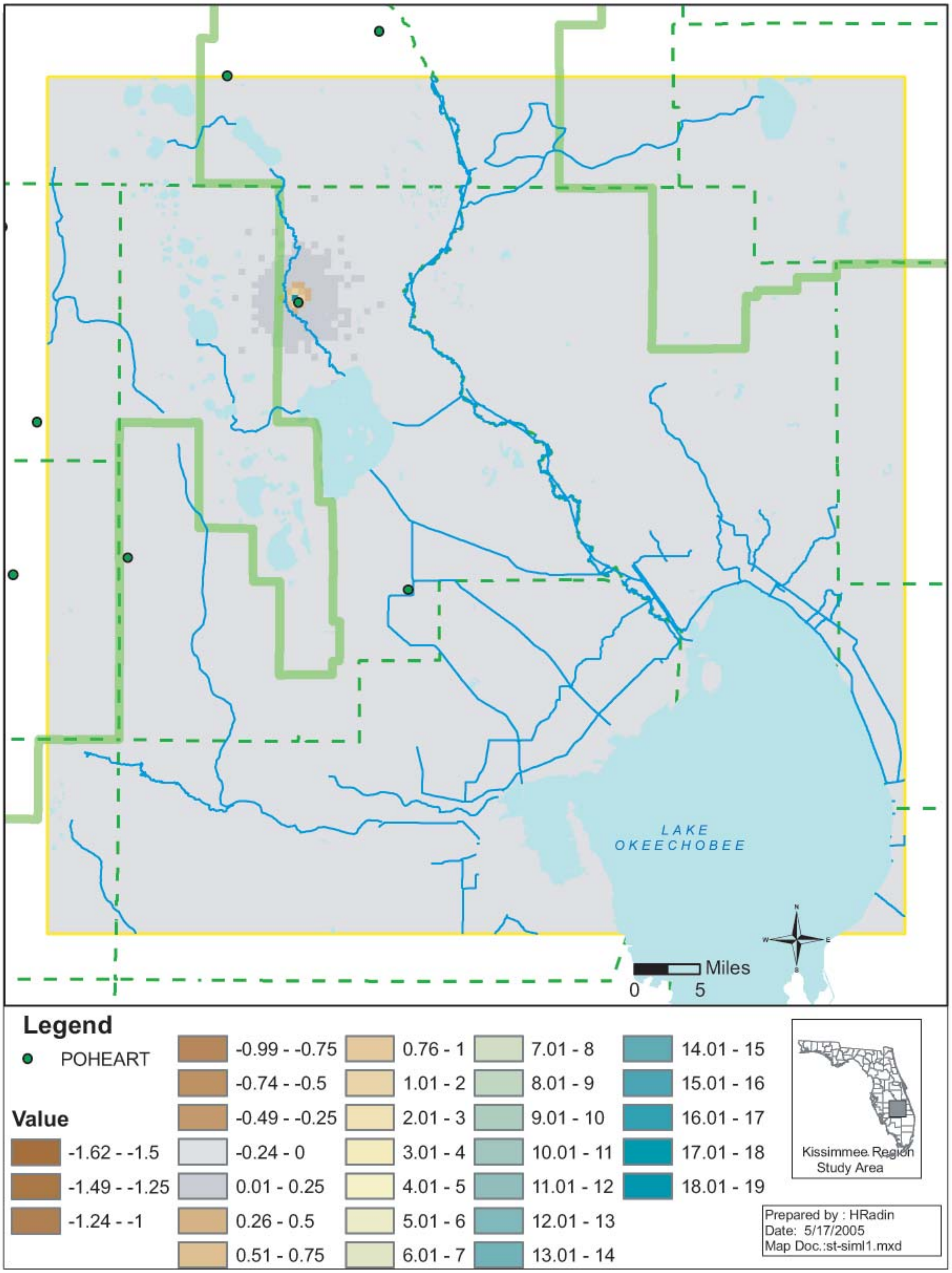

Figure D-14. Difference AFSIRS Ag – G63 Wellfield Upper Floridan Aquifer.

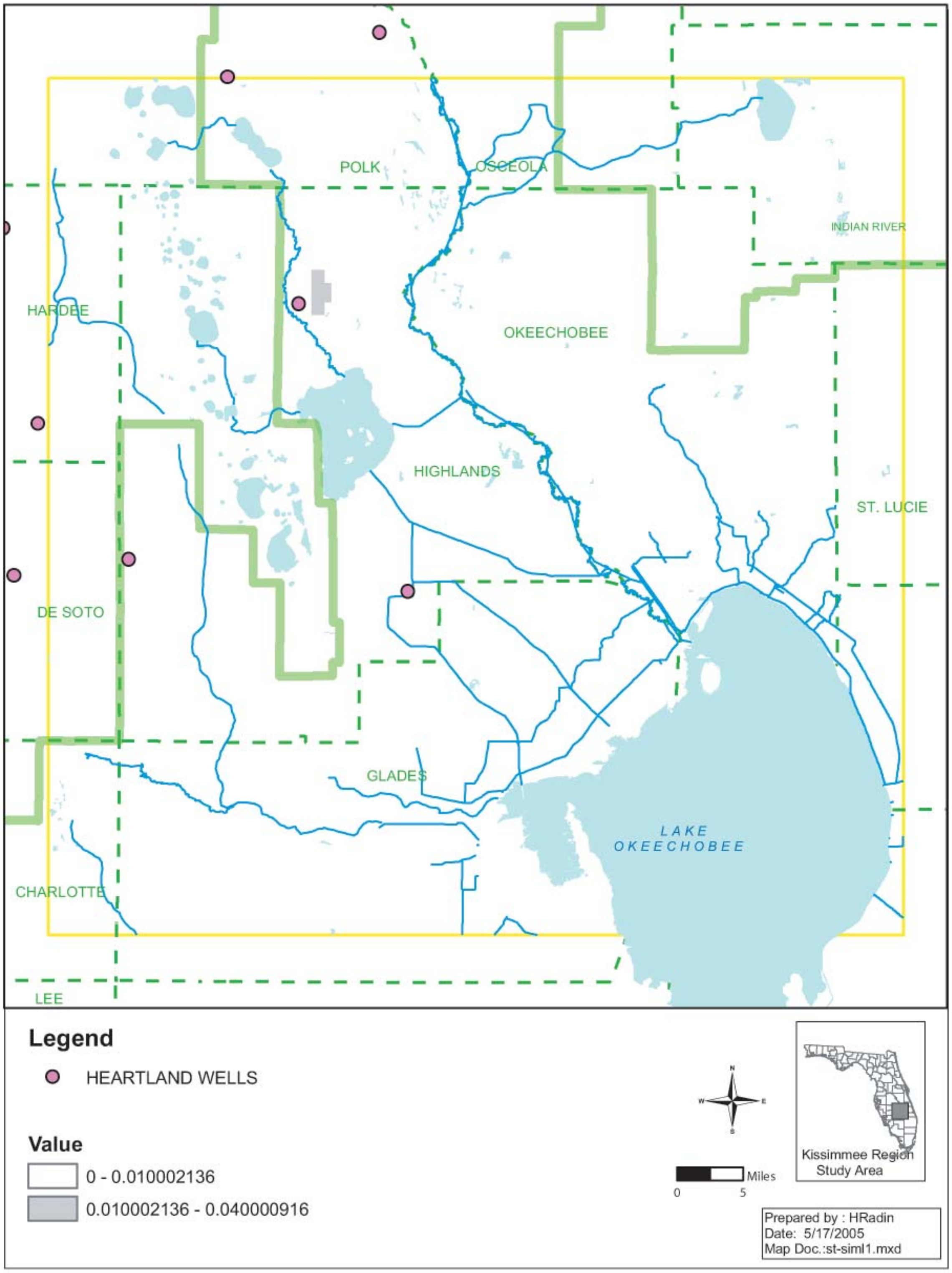

Figure D-15. Difference AFSIRS Ag – G63 Wellfield Surficial Aquifer.

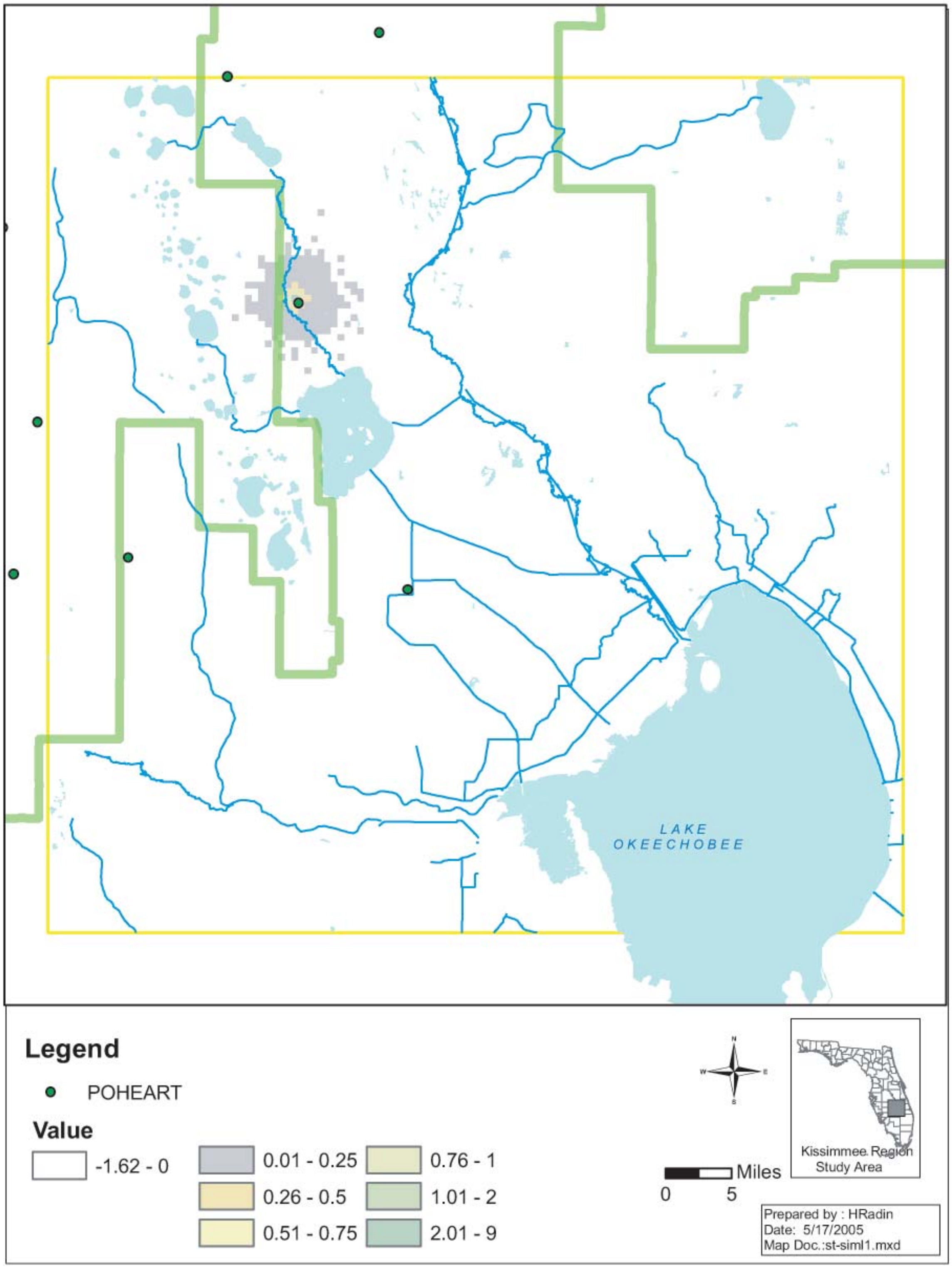

Figure D-16. Difference AFSIRS Ag – G63 Wellfield Middle Floridan Aquifer.

1995 AFSIRS Ag and Well G64

This simulation run uses the same files as the 1995 AFSIRS Ag run with the addition of one more wellfield – G64 in the Upper Floridan Aquifer. For modeling purposes, the proposed wellfield was placed in Layer 2, Row 77 and Column 55. The model assumes that all the consumption is from one well in the center of the cell. This well simulates pumping 5 MGD or 668,500 ft^3/day. The proposed site for G64 places it in Highlands County near the C-41 Canal. The purpose of this simulation is to evaluate the impact of this well on the water levels. This is done by creating drawdown maps, which compare the water levels without well G64 – in this case, the 1995 AFSIRS Ag Run, to the water levels with the G64 well.

The local drawdown in the Upper Floridan Aquifer in cell 2, 77 and 55 is 25.63 feet. One cell away (2,640 feet away); the drawdown ranges from 2 to 5 feet. A mile away the drawdown decreases to 0.8–1.3 feet. At a 1.5-mile radius from G64, the drawdown is 0.5 feet. For about an 8-mile radius, there is a drawdown of about 0.25 feet. This drawdown area extends into the SWFWMD (**Figure D-17**).

No significant impact was seen in the Surficial Aquifer System – the water levels in a few scattered cells changed by up to 0.1 feet (**Figure D-18**).

The Middle Floridan Aquifer showed a drawdown of up to 1.18 feet in cell 3, 77 and 55. A 0.5 foot drawdown occurred a mile further out from G64. The area of the drawdown cone "footprint," seen in the Upper Floridan Aquifer, showed drawdowns of up to 0.25 feet (**Figure D-19**).

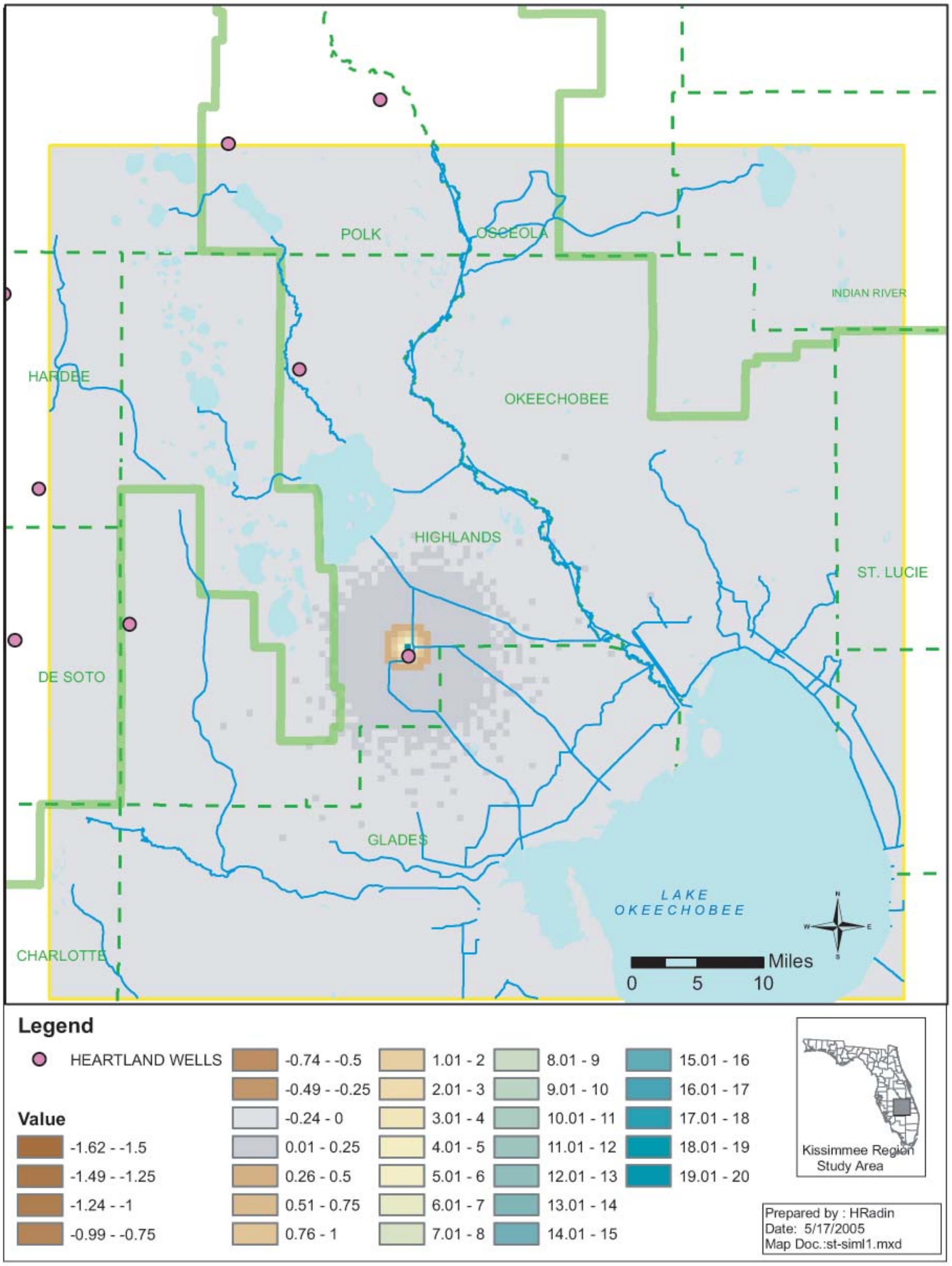

Figure D-17. Difference AFSIRS Ag – G64 Wellfield Upper Floridan Aquifer.

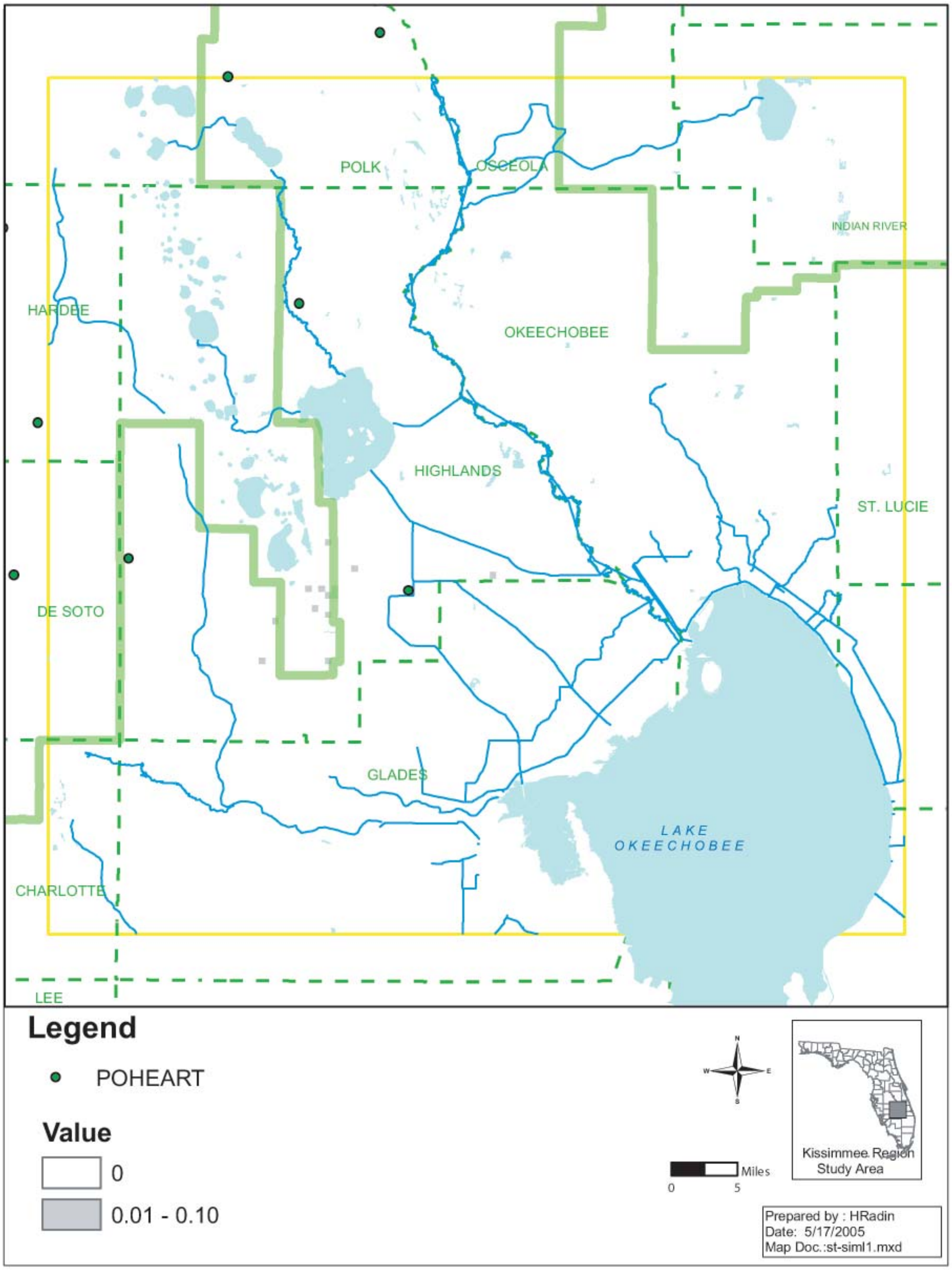

Figure D-18. Difference AFSIRS Ag – G64 Wellfield Surficial Aquifer.

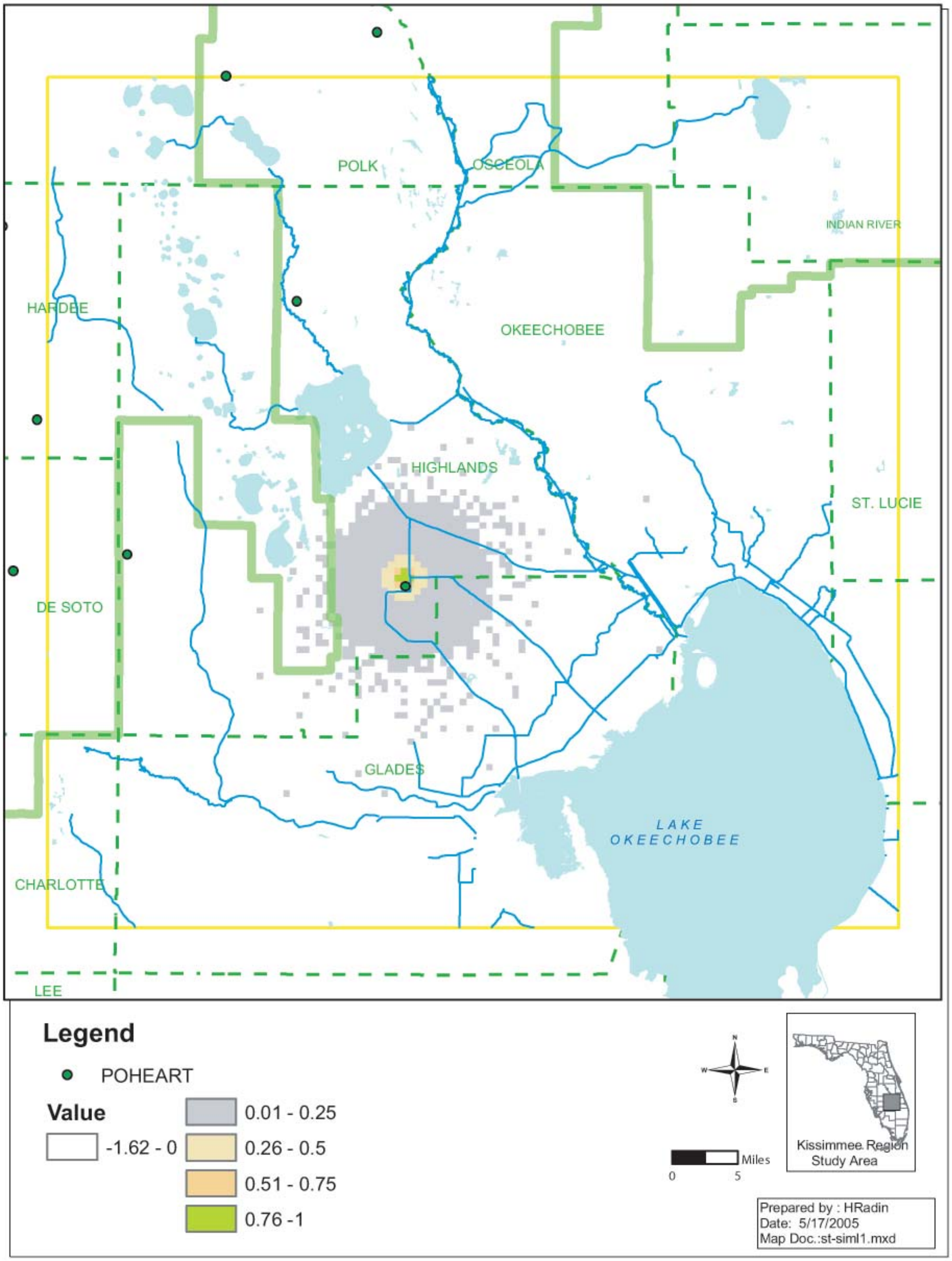

Figure D-19. Difference AFSIRS Ag – G64 Wellfield Middle Floridan Aquifer.

1995 1-in-10 Simulation Run

The 1995 1-in-10 simulation run used the same files as the 1995 AFSIRS run, with the exception of the Evapotranspiration, Recharge and Agriculture consumption well files. These files were modified for the 1-in-10 rainfall conditions. These files are still based on the 1995 land use conditions.

During the 1-in-10 year simulation, the irrigation demands for all the wells in the model area was increased to 316 MGD, while with average 1995 water conditions the demand was only 200 MGD.

The water levels in the Surficial Aquifer System drop significantly during the 1-in-10 simulations (**Figure D-20**). The areas that changed the most were the wetlands and other non-irrigated areas (Blue Cypress marsh, and the urban areas on Lake Wales Ridge).

The water levels in the Upper Floridan Aquifer do not change as much (**Figure D-21**). Some of the irrigated areas show water levels up to 1.5 feet higher during the 1-in-10 rainfall conditions than during the average 1995 conditions. The water levels in Blue Cypress Marsh and under Avon Park Ridge decreased by up to 4 feet. Most areas declined by less than 2 feet.

The water levels in the Middle Floridan Aquifer show the same general pattern as the Upper Floridan, but the impact is only 0.25 feet in most of the model area and up to 2.5 feet in Blue Cypress Marsh (**Figure D-22**).

For most of the model area, the simulated water levels in the Middle Floridan Aquifer are up to 2 feet higher than in the Upper Floridan Aquifer (**Figure D-23**). Close to the Kissimmee River, the water levels in the Upper Floridan may be higher than those in the Middle Floridan by up to 2 feet. In some areas along Lake Wales Ridge, the water levels in the Middle Floridan may be up to 5 feet higher than the Upper Floridan Aquifer.

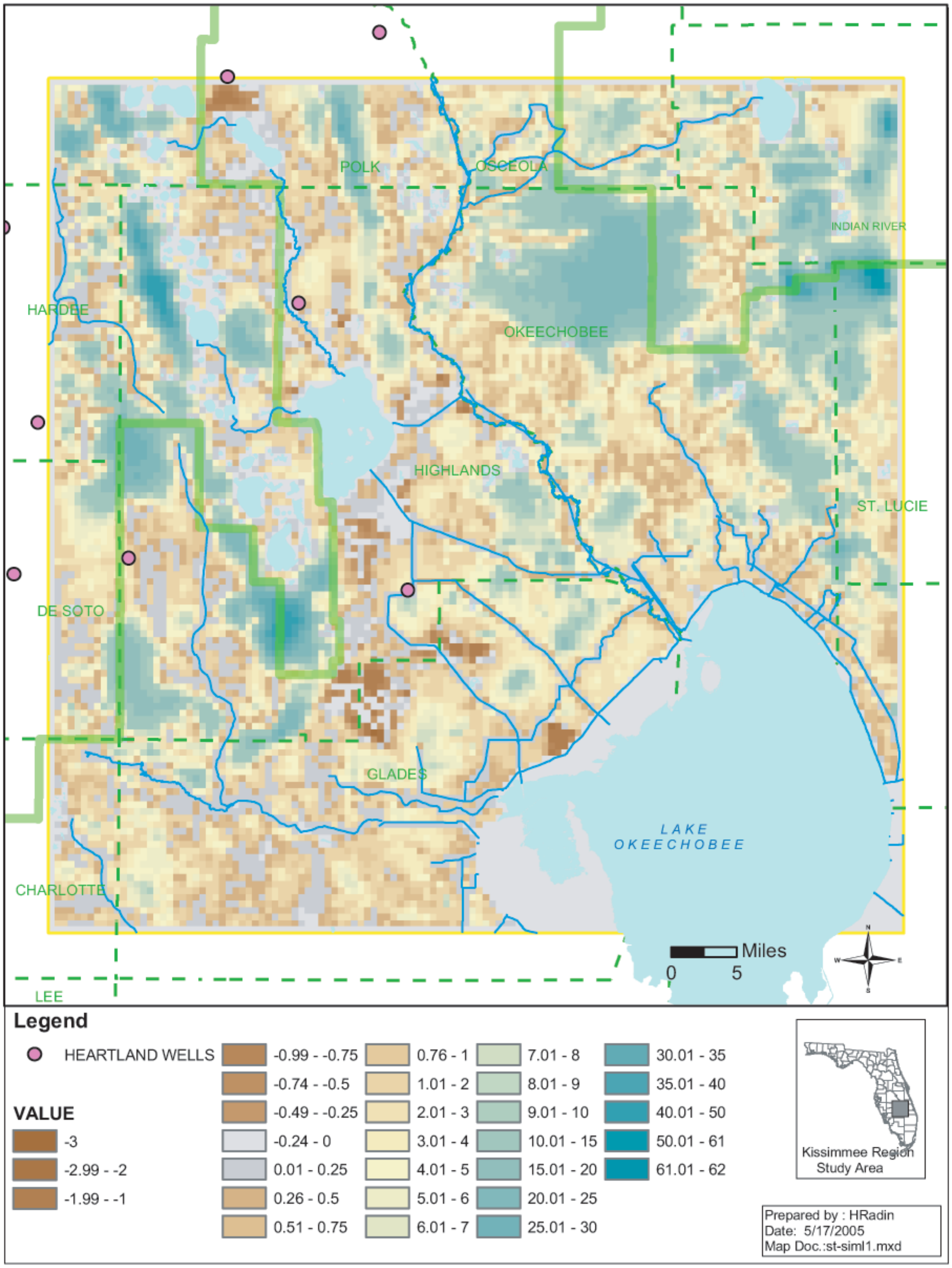

Figure D-20. Difference in Water Levels 1995 Ag and 1995 1-in-10 Surficial Aquifer.

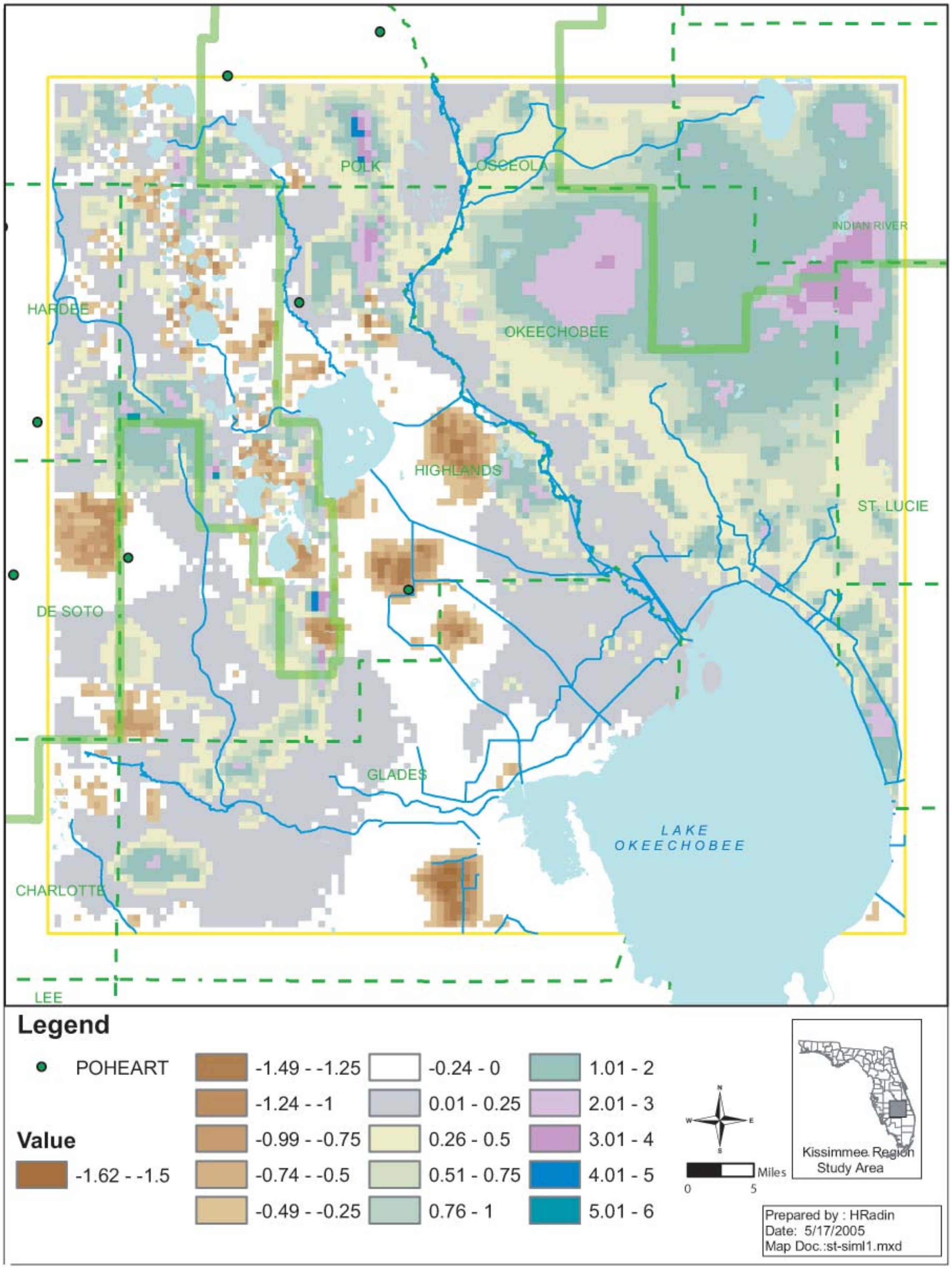

Figure D-21. Difference in 1995 AFSIRS Ag and 1995 1-in-10 Water Levels Upper Floridan Aquifer.

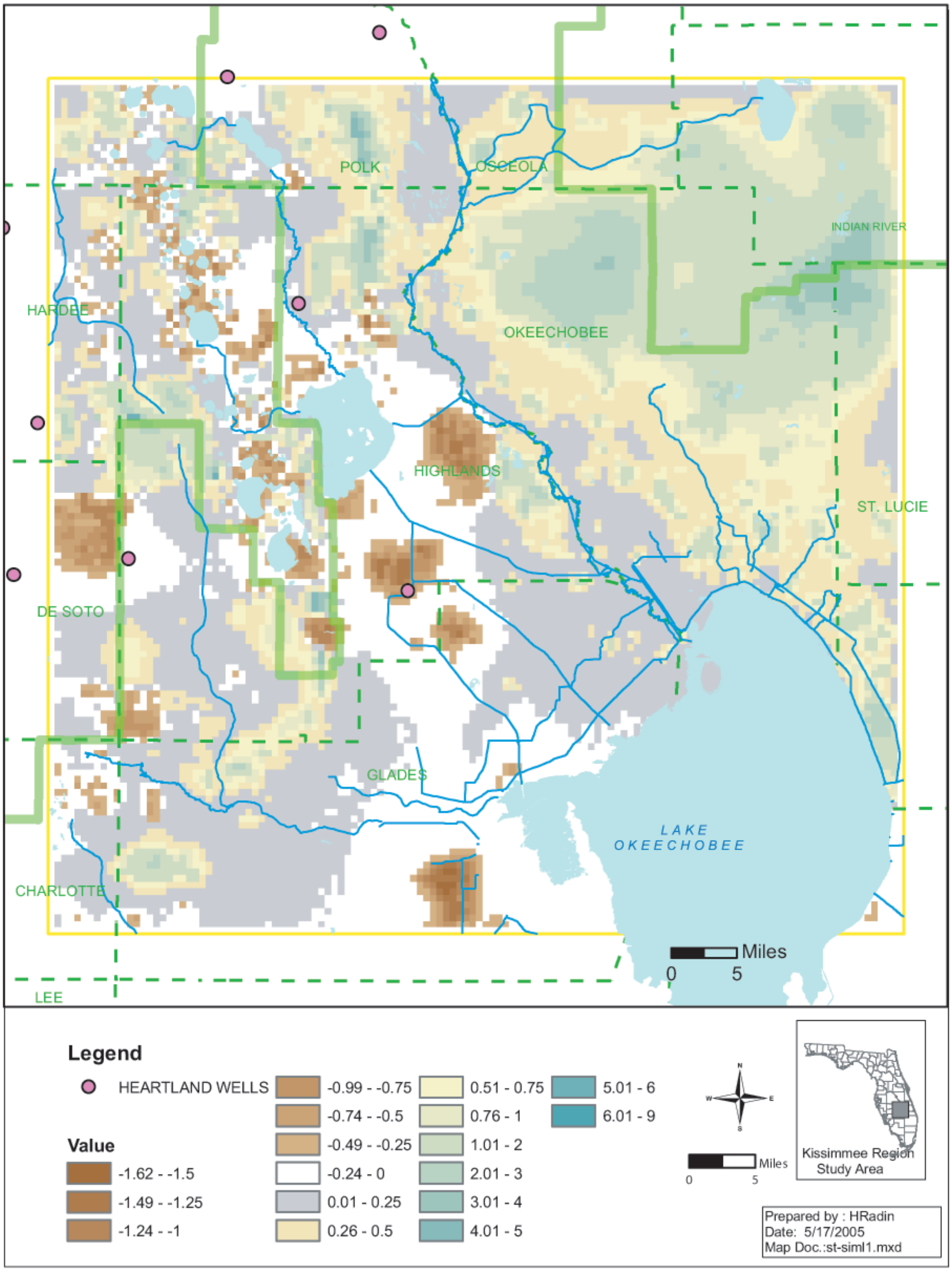

Figure D-22. Difference in Water Levels 1995 Ag and 1995 1-in-10 Upper Floridan Aquifer.

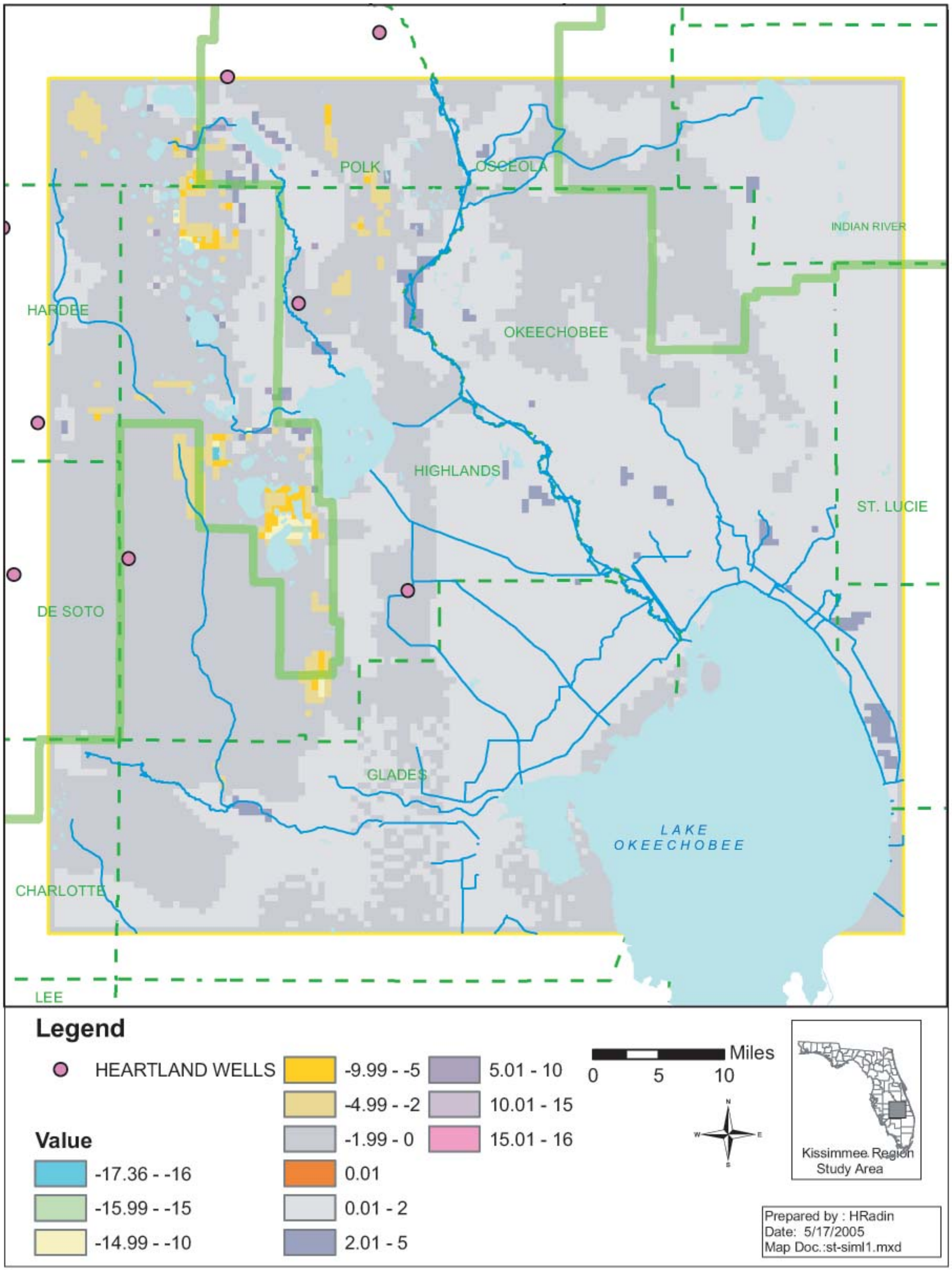

Figure D-23. Difference in Water Levels 1995 1-in-10 Run Layer 3 – Layer 2 (MF – UF).

1995 1-in-10 and Well G62

This simulation run uses the same files as the 1995 1-in-10 run with the addition of one more wellfield – G62 in the Upper Floridan Aquifer. For modeling purposes, the proposed wellfield was placed in Layer 2, Row 73 and Column 12. The model assumes that all the consumption is from one well in the center of the cell. This well simulates pumping 2 MGD or 267,400 ft^3/day. The proposed site for G62 places it near the SFWMD/SWFWMD boundary on the Highlands/De Soto county line. The purpose of this simulation is to evaluate the impact of this well on the water levels. This is done by creating drawdown maps, which compare the water levels without well G62 – in this case, the 1995 1-in-10 simulation – to the water levels with the G62 well. The results of this simulation are nearly identical to those seen in the 1995 AFSIRS + G62 simulation. This indicates there is not very much recharge from the Surficial Aquifer System in the area of this proposed well.

The local drawdown in the Upper Floridan Aquifer in cell 2, 73 and 12 is 13.31 feet. One cell away (2,640 feet), the drawdown ranges from 0.5 to 2 feet. At a mile radius the drawdown decreases to 0.33 feet. For nearly a 10-mile radius there is a drawdown of about 0.25 feet. Half of the drawdown area falls in the SWFWMD (**Figure D-24**).

No impact was seen in the Surficial Aquifer System – the water levels throughout the model changed by a maximum of 0.01 feet (**Figure D-25**).

The Middle Floridan Aquifer showed a drawdown of up to 0.2 feet for a radius of about 3 miles (**Figure D-26**).

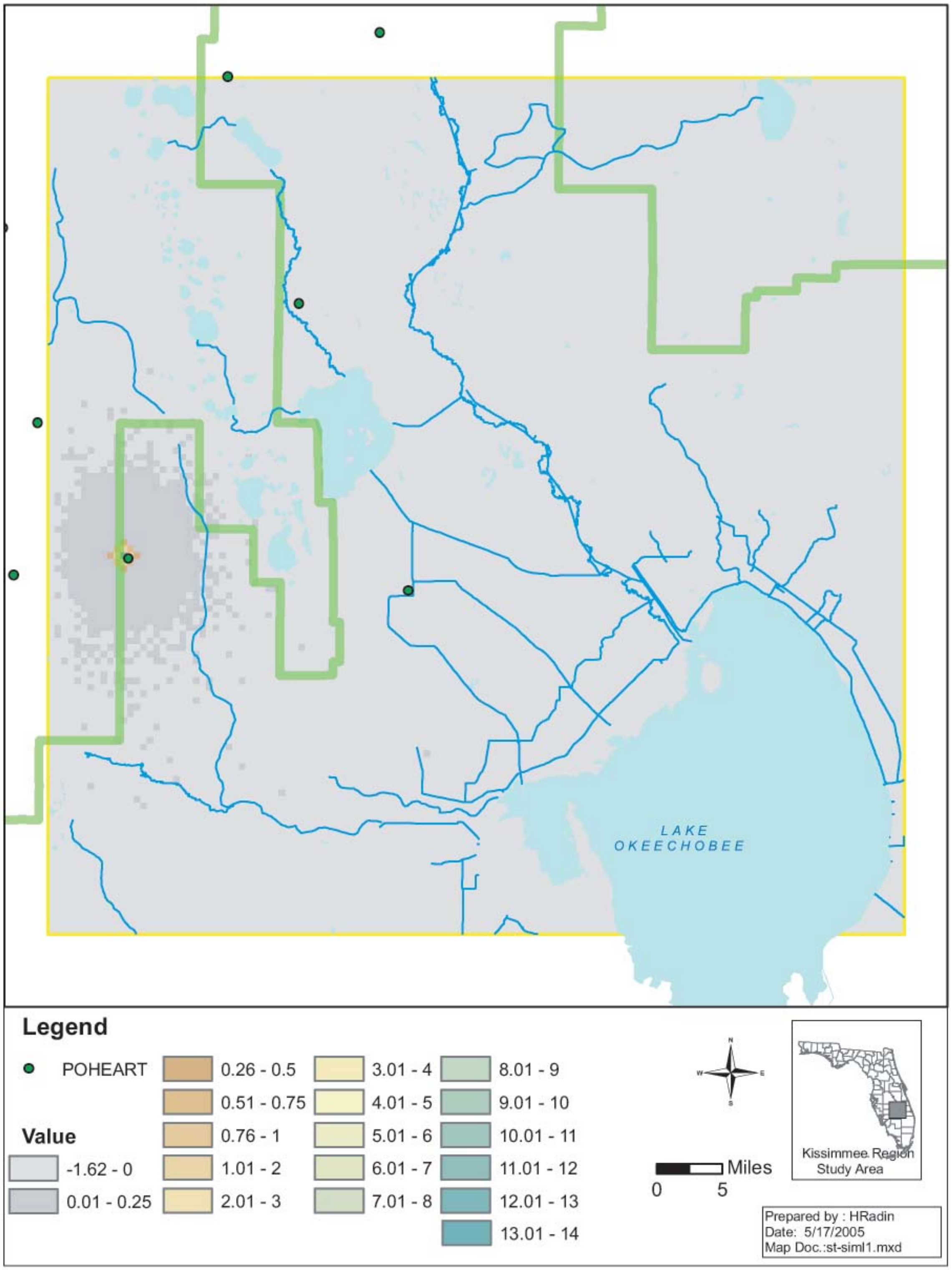

Figure D-24. Difference 1995 1-in-10 – G62 Wellfield Upper Floridan Aquifer.

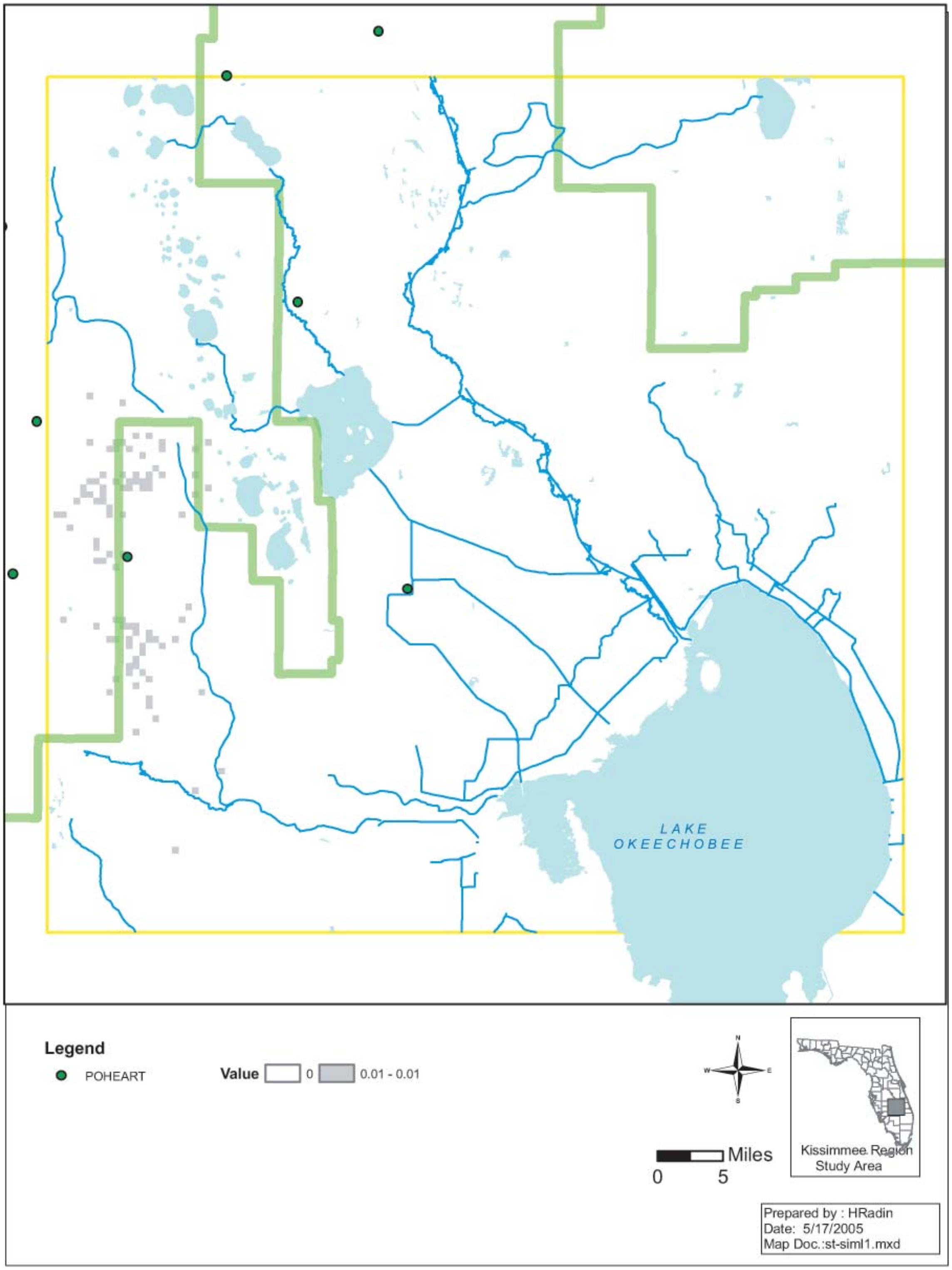

Figure D-25. Difference 1995 1-in-10 – G62 Wellfield Surficial Aquifer.

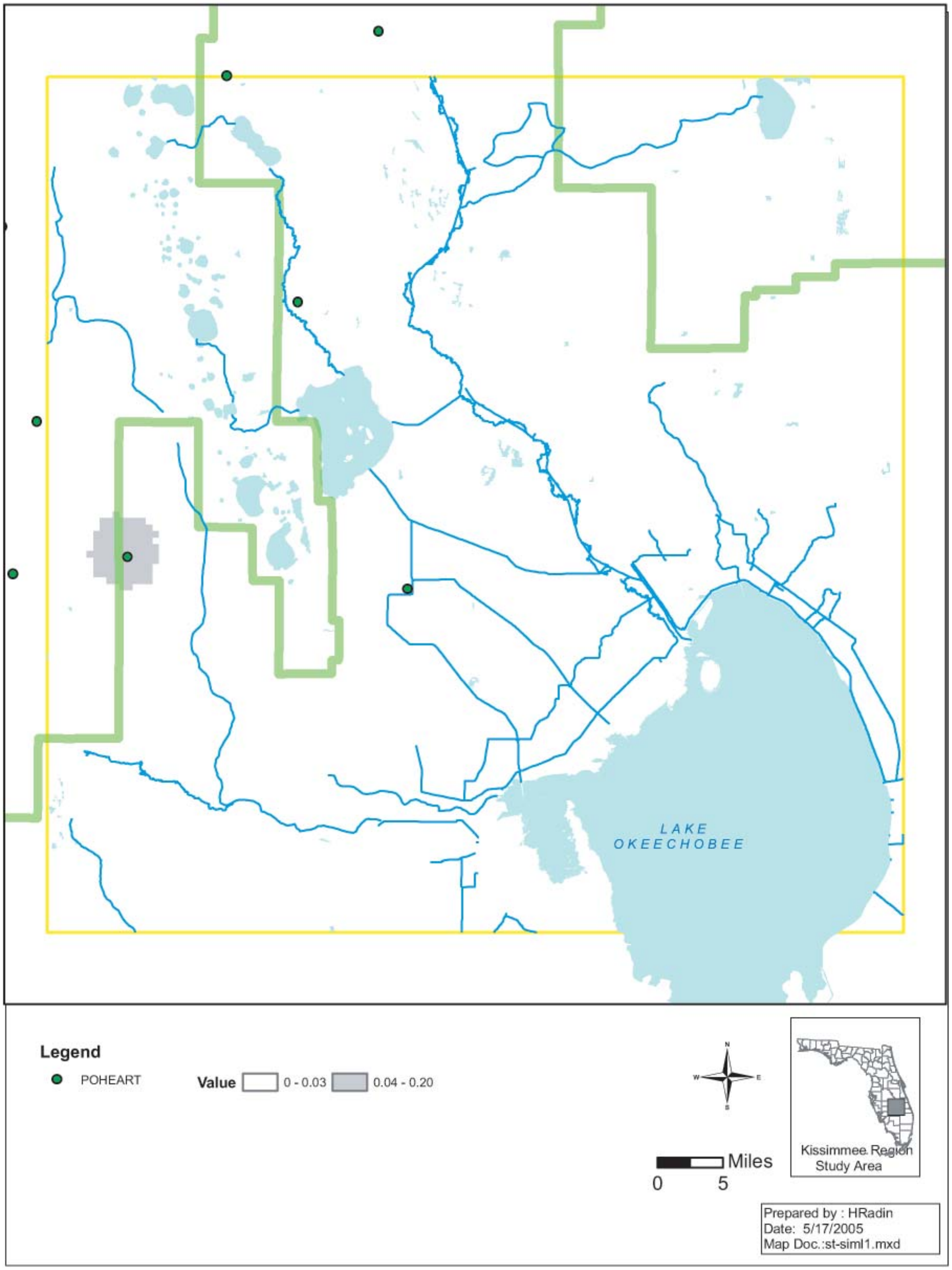

Figure D-26. Difference 1995 1-in-10 – G62 Wellfield Middle Floridan Aquifer.

1995 1-in-10 and Well G63

This simulation run uses the same files as the 1995 1-in-10 Ag run with the addition of one more wellfield – G63 in the Upper Floridan Aquifer. For modeling purposes, the proposed wellfield was placed in Layer 2, Row 34 and Column 38. The model assumes that all the consumption is from one well in the center of the cell. This well will pump 2 MGD or 267,400 ft^3/day. The proposed site for G63 places it in Highlands County near the SFWMD/SWFWMD boundary near Arbuckle Creek, north of Lake Istokpoga. The purpose of this simulation is to evaluate the impact of this well on the water levels. This is done by creating drawdown maps, which compare the water levels without well G63 – in this case, the 1995 1-in-10 Ag run – to the water levels with the G63 well. The impact seen with this simulation is nearly identical to that seen in the 1995 AFSIRS + G63 simulation. This indicates there is not very much recharge from the Surficial Aquifer System in the area of this proposed well.

The local drawdown in the Upper Floridan Aquifer in cell 2, 34 and 38 is 18.29 feet. One cell away (2,640 feet), the drawdown ranges from 0.6 to 1.8 feet. A mile away this decreases to 0.25 feet. For a 5-mile radius, there is a drawdown of about 0.25 feet. This drawdown area extends into the SWFWMD (**Figure D-27**).

No impact was seen in the Surficial Aquifer System – some cells east of the wellfield changed by a maximum of 0.04 feet. The area with drawdown in the Surficial Aquifer System is larger than that seen in the average 1995 year simulation (**Figure D-28**).

The Middle Floridan Aquifer showed a drawdown of up to 2 feet in cell 3, 34 and 38, a 0.75 foot drawdown one cell over (2,640 feet) and up to 0.5 in an area slightly larger than the drawdown cone "footprint" seen in the Upper Floridan Aquifer (**Figure D-29**).

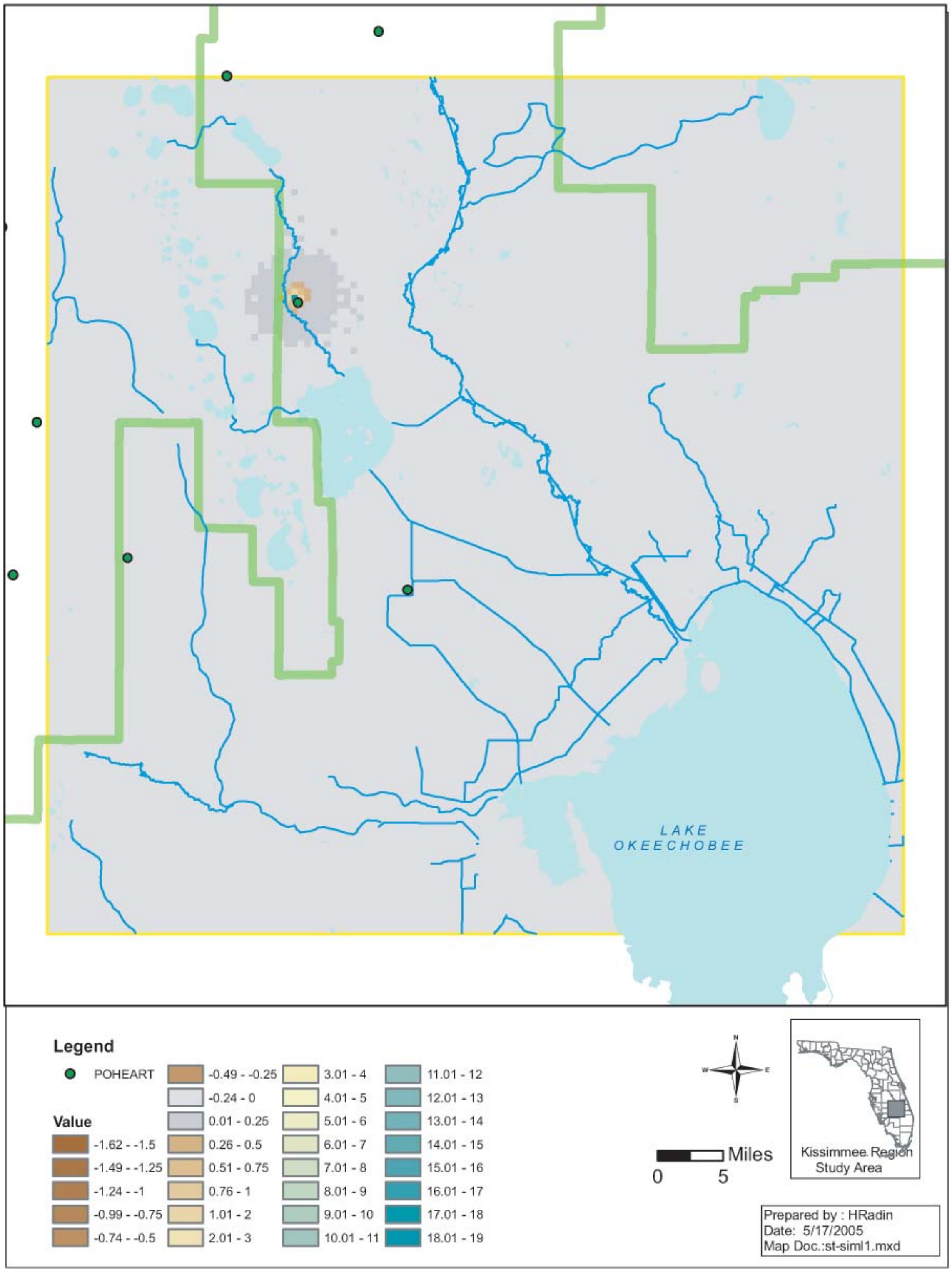

Figure D-27. Difference 1995 1-in-10 – G63 Wellfield Upper Floridan Aquifer.

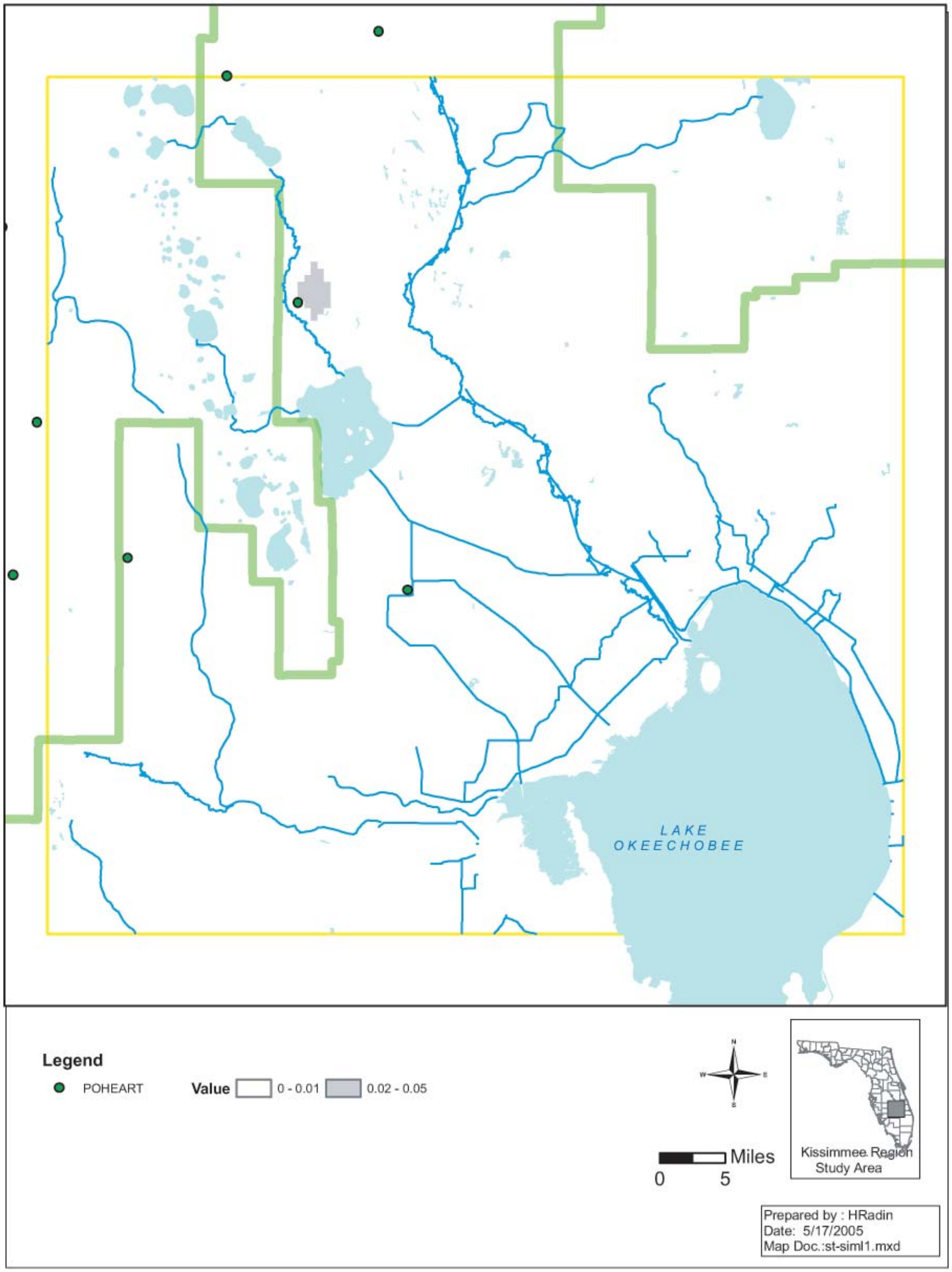

Figure D-28. Difference 1995 1-in-10 – G63 Wellfield Surficial Aquifer.

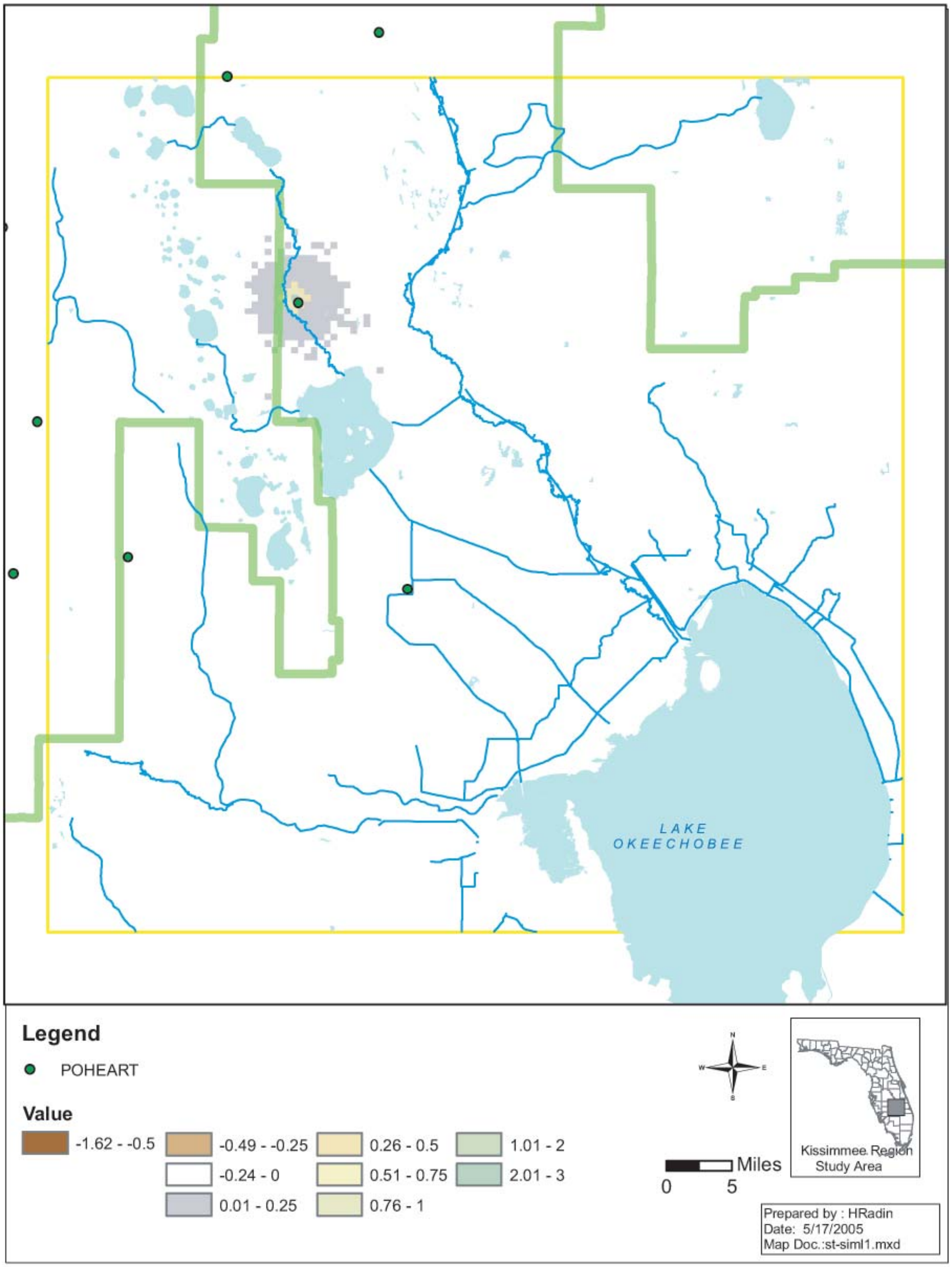

Figure D-29. Difference 1995 1-in-10 – G63 Wellfield Middle Floridan Aquifer.

1995 1-in-10 and Well G64

This simulation run uses the same files as the 1995 1-in-10 run with the addition of one more wellfield – G64 in the Upper Floridan Aquifer. For modeling purposes, the proposed wellfield was placed in Layer 2, Row 77 and Column 55. The model assumes that all the consumption is from one well in the center of the cell. This well will pump 5 MGD or 668,500 ft^3/day. The proposed site for G64 places it in Highlands County near the C-41 Canal. The purpose of this simulation is to evaluate the impact of this well on the water levels. This is done by creating drawdown maps, which compare the water levels without well G64 – in this case the 1995 1-in-10 run – to the water levels with the G64 well. The impact resulting impacts seen with this simulation are nearly identical to those seen in the 1995 AFSIRS + G64 simulation. This indicates there is not very much recharge from the Surficial Aquifer System in the area of this proposed well.

The local drawdown in the Upper Floridan Aquifer in cell 2, 77 and 55 is 25.63 feet. One cell away (2,640 feet), the drawdown ranges from 2 to 5 feet. A mile away this drawdown decreases to 0.8–1.3 feet. At a 1.5-mile radius, the drawdown decreases to 0.5 feet. For about an 8-mile radius, there is a drawdown of about 0.25 feet. This drawdown area extends into the SWFWMD (**Figure D-30**).

No impacts were seen in the Surficial Aquifer System – the water levels in a few scattered cells changed by up to 0.1 feet (**Figure D-31**).

The Middle Floridan Aquifer showed a drawdown of up to 1.18 feet in cell 3, 77 and 55, a drawdown of 0.5 feet over the next mile, then up to 0.25 feet drawdown in the drawdown cone "footprint," seen in the Upper Floridan Aquifer (**Figure D-32**).

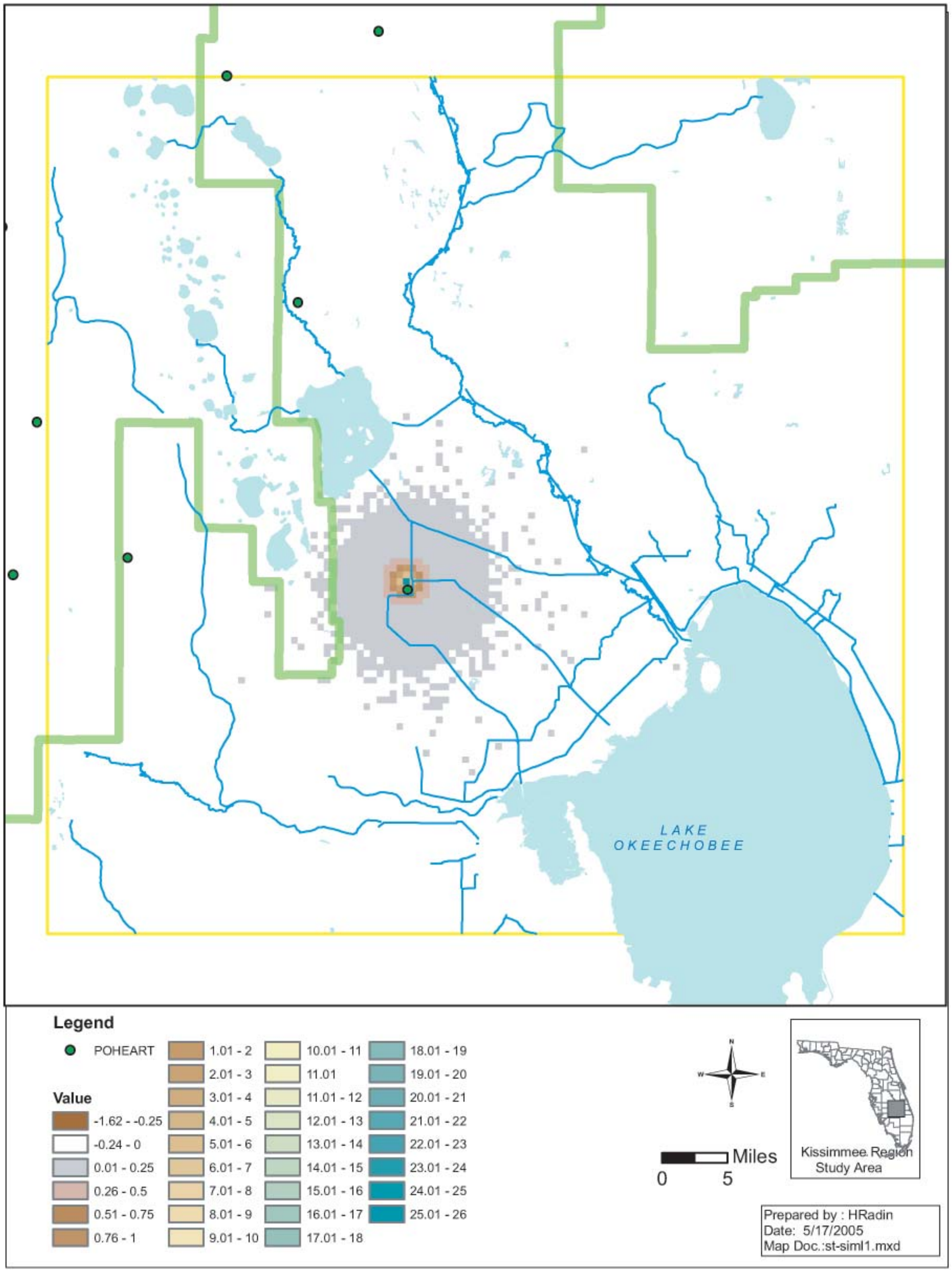

Figure D-30. Difference 1995 1-in-10 – G64 Wellfield Upper Floridan Aquifer.

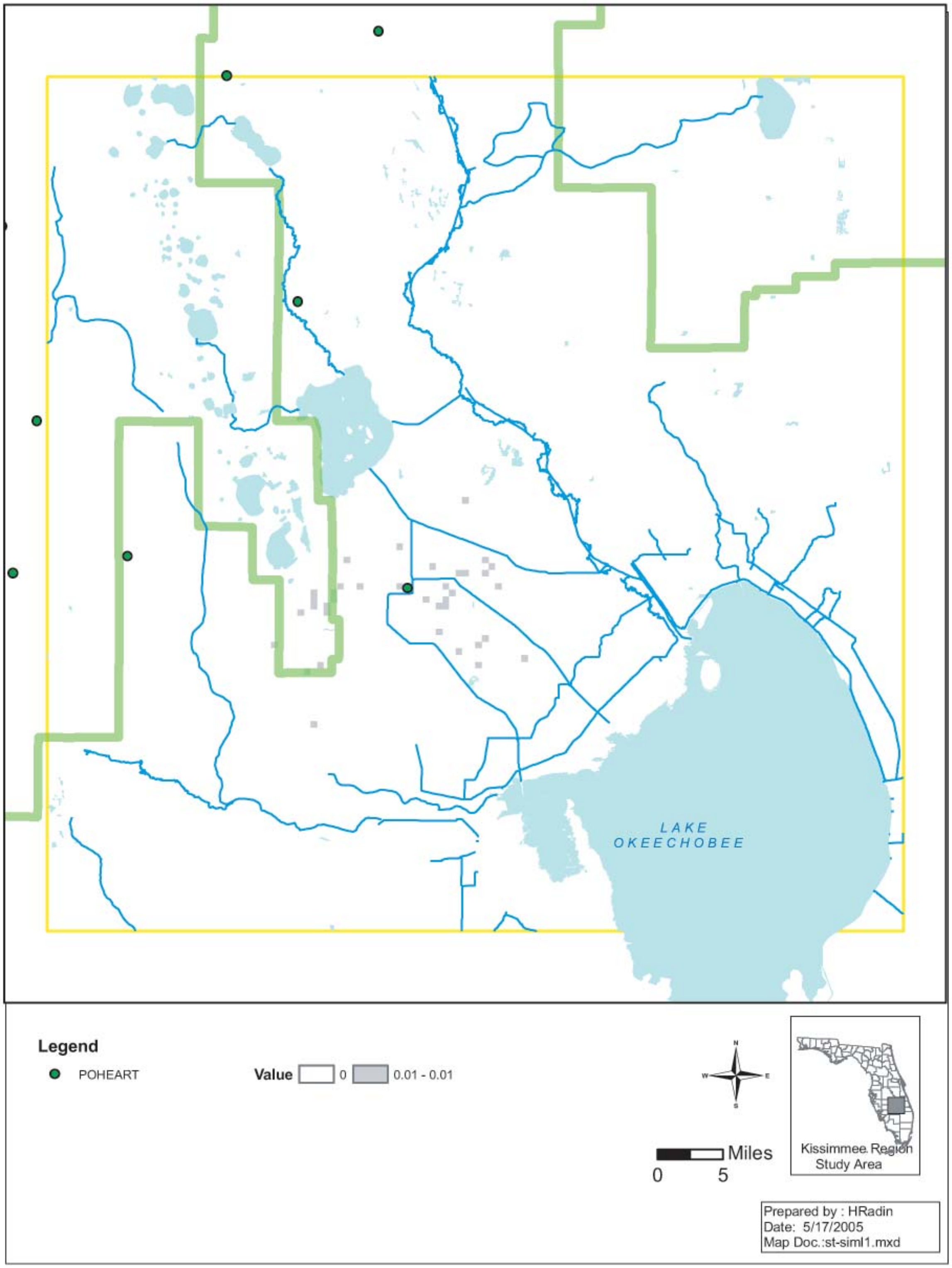

Figure D-31. Difference 1995 1-in-10 – G64 Wellfield Surficial Aquifer.

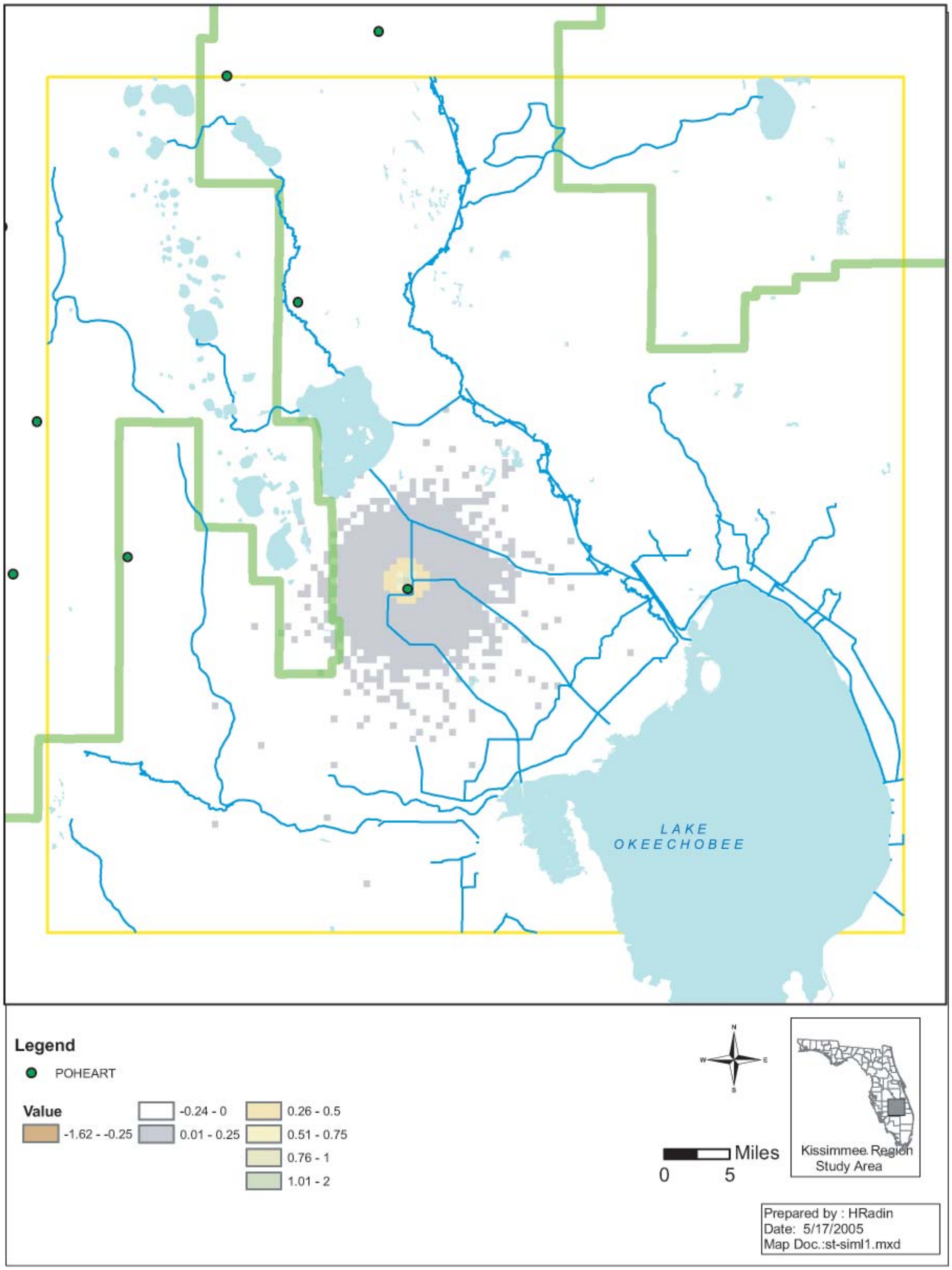

Figure D-32. Difference 1995 1-in-10 – G64 Wellfield Middle Floridan Aquifer.

2025 1-in-10 Simulation Run

The 2025 1-in-10 simulation run used the same files as the 1995 base run, with the exception of the Public Water Supply well file (detailed in the previous projected withdrawal section) and the Evapotranspiration, Recharge and Agriculture consumption well files. The Evapotranspiration, Recharge and Agriculture well files were modified for the 1-in-10 rainfall conditions. These files are based on the predicted 2025 land use conditions. In 2025, due to the urbanization of the land use, the predicted agricultural consumption based on AFSIRS is 477 MGD as compared to 316 MGD in 1995 with 1-in-10 conditions.

The areas where flowing artesian conditions exist in the Upper Floridan Aquifer remain unchanged from the areas displayed in the calibration run (Radin 2005) (**Figure D-33**).

The simulated water levels for the Middle Floridan Aquifer are within 2 feet of the simulated water levels for the Upper Floridan Aquifer (**Figure D-34**). In the areas where the confining unit between these layers is thinner (east of the Kissimmee River), and west of Lake Wales Ridge, the water levels in the Middle Floridan are higher than in the Upper Floridan Aquifer. In the area just west of the Kissimmee River, the water levels in the Middle Floridan are higher or the same as in the Upper Floridan Aquifer.

When comparing water levels for the 2025 1-in-10 simulation run and the 1995 1-in-10 run for the Upper Floridan Aquifer, there appears to be a clear divide (**Figure D-35**). The water level east of the Kissimmee River – mainly in areas that are predicted to urbanize by 2025 – show water levels are higher in 2025 by up to 1.6 feet as compared with the agricultural areas west of the Kissimmee River, which show water levels declining from 0.25 to 5 feet in 2025.

A similar divide is seen in the Middle Floridan Aquifer, where the water levels are up to 1.5 feet higher west of the Kissimmee River, and up to 1.5 feet lower east of the Kissimmee River (**Figure D-36**).

The greatest differences are seen in the Surficial Aquifer System (**Figure D-37**), which is influenced by the changes in land use, and more directly influenced by the modified Rain, Evapotranspiration and Recharge values. The standard deviation of water level differences is 3.74 feet. Some areas in Okeechobee County showed changes of 15 feet, with the water levels in 2025 being higher. In the Fisheating Creek area, the water levels are 5 to 10 feet lower in 2025. In the Lakes Wales Ridge area, water levels were higher west of the ridge and lower east of it.

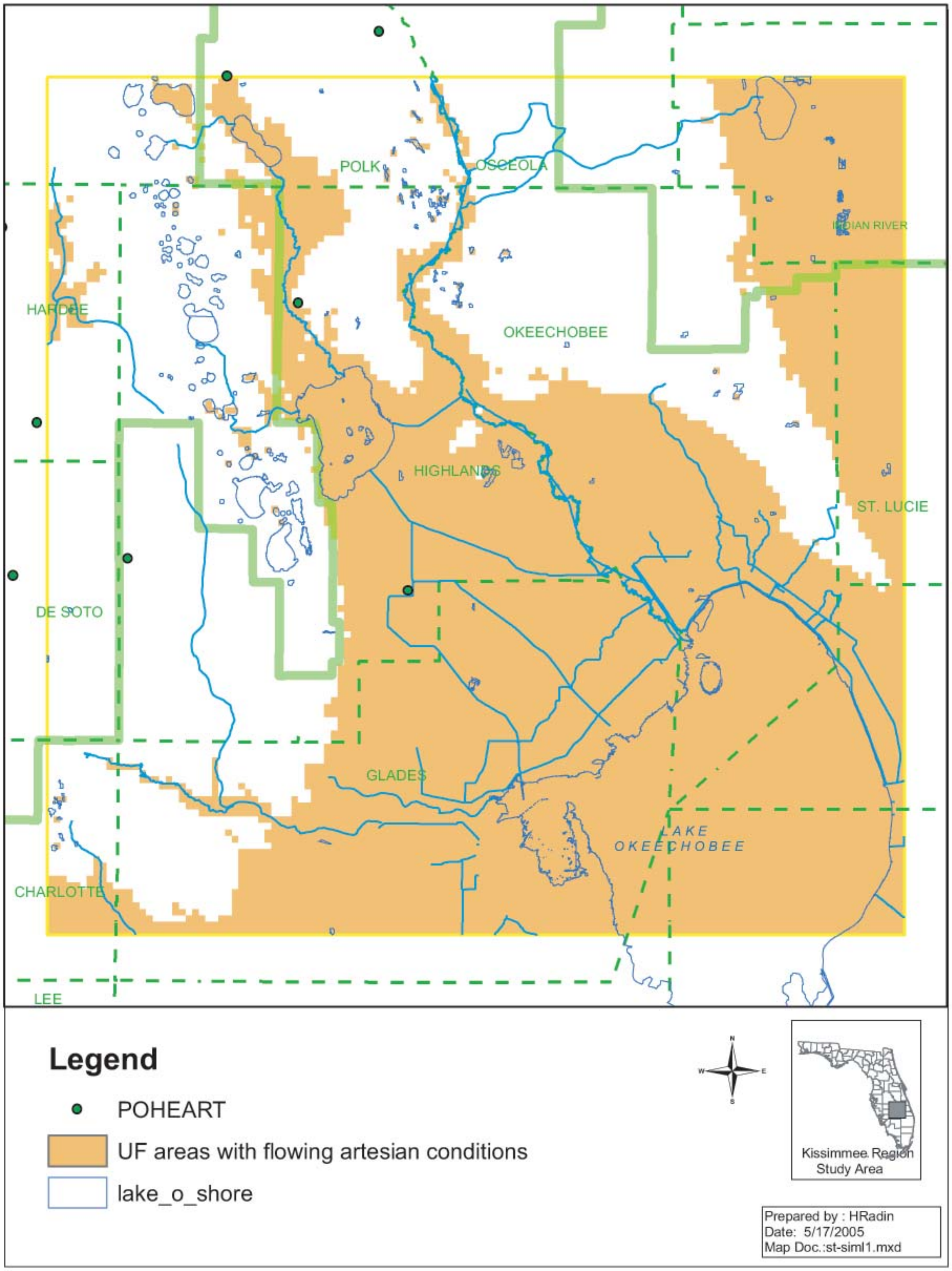

Figure D-33. Upper Floridan Areas with Flowing Artesian Conditions.

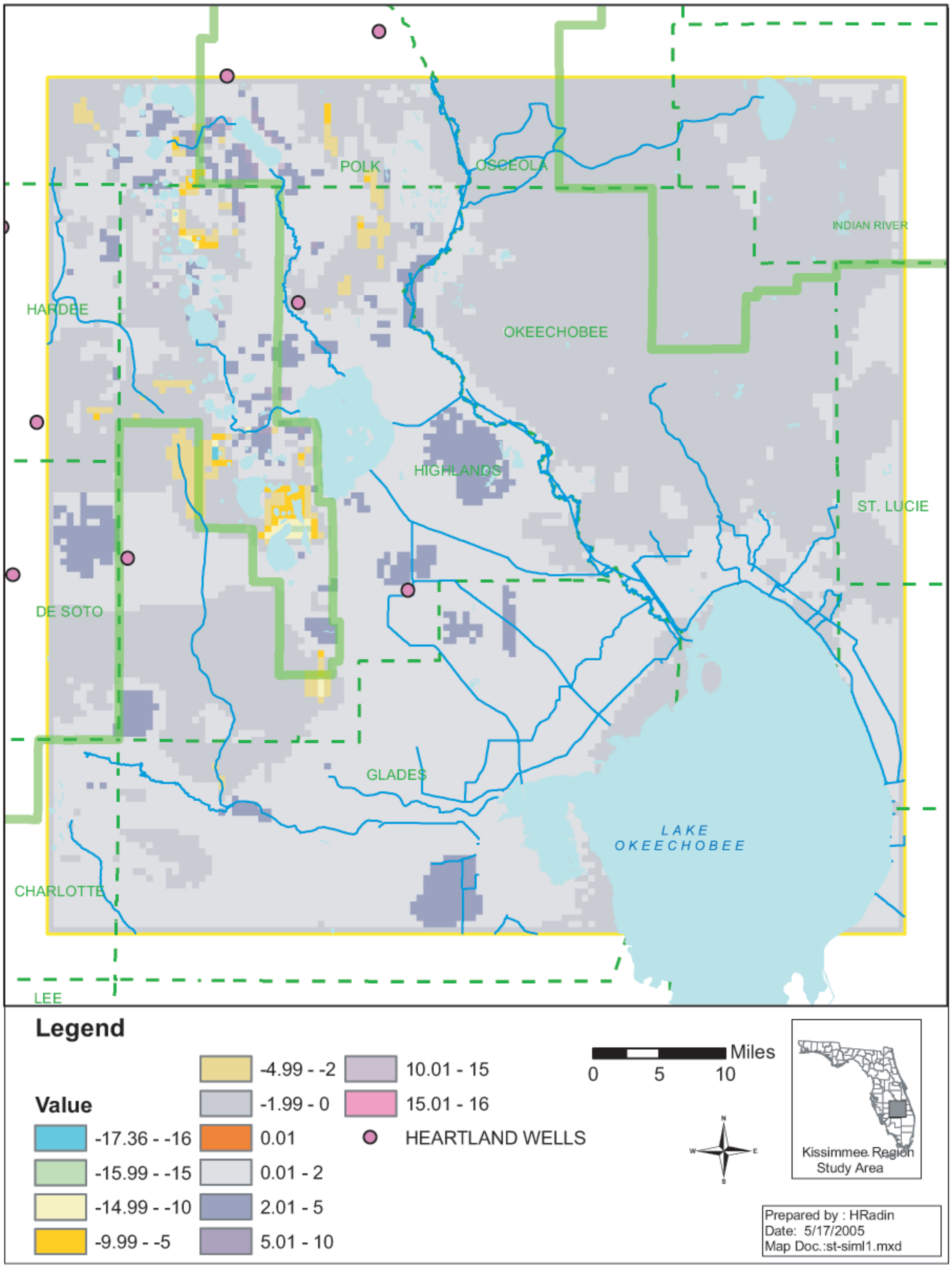

Figure D-34. Difference in Water Levels Layer 3 – Layer 2 (MF – UF).

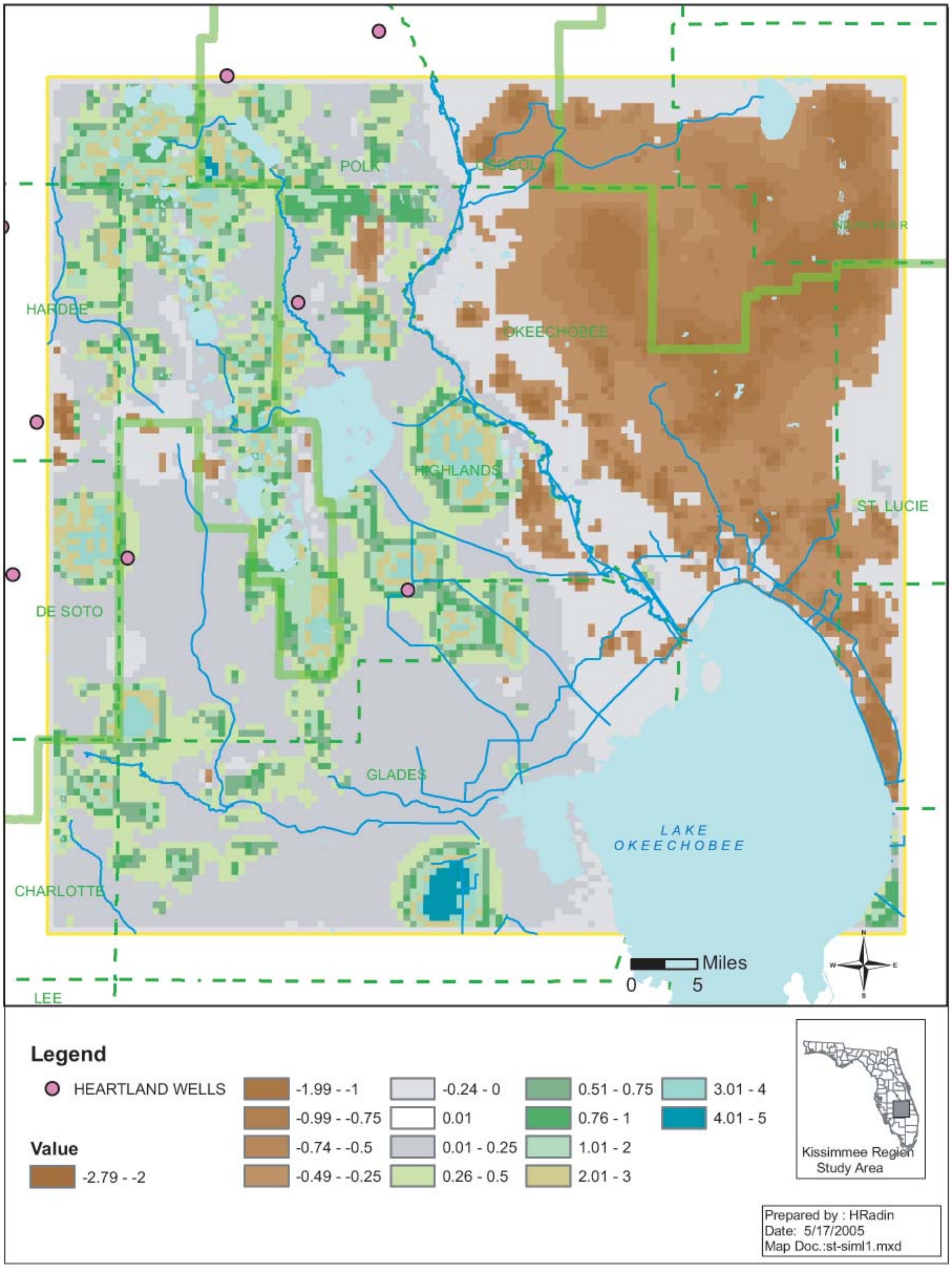

Figure D-35. Difference in Water Levels 1995 1-in-10 and 2025 1-in-10 Upper Floridan Aquifer.

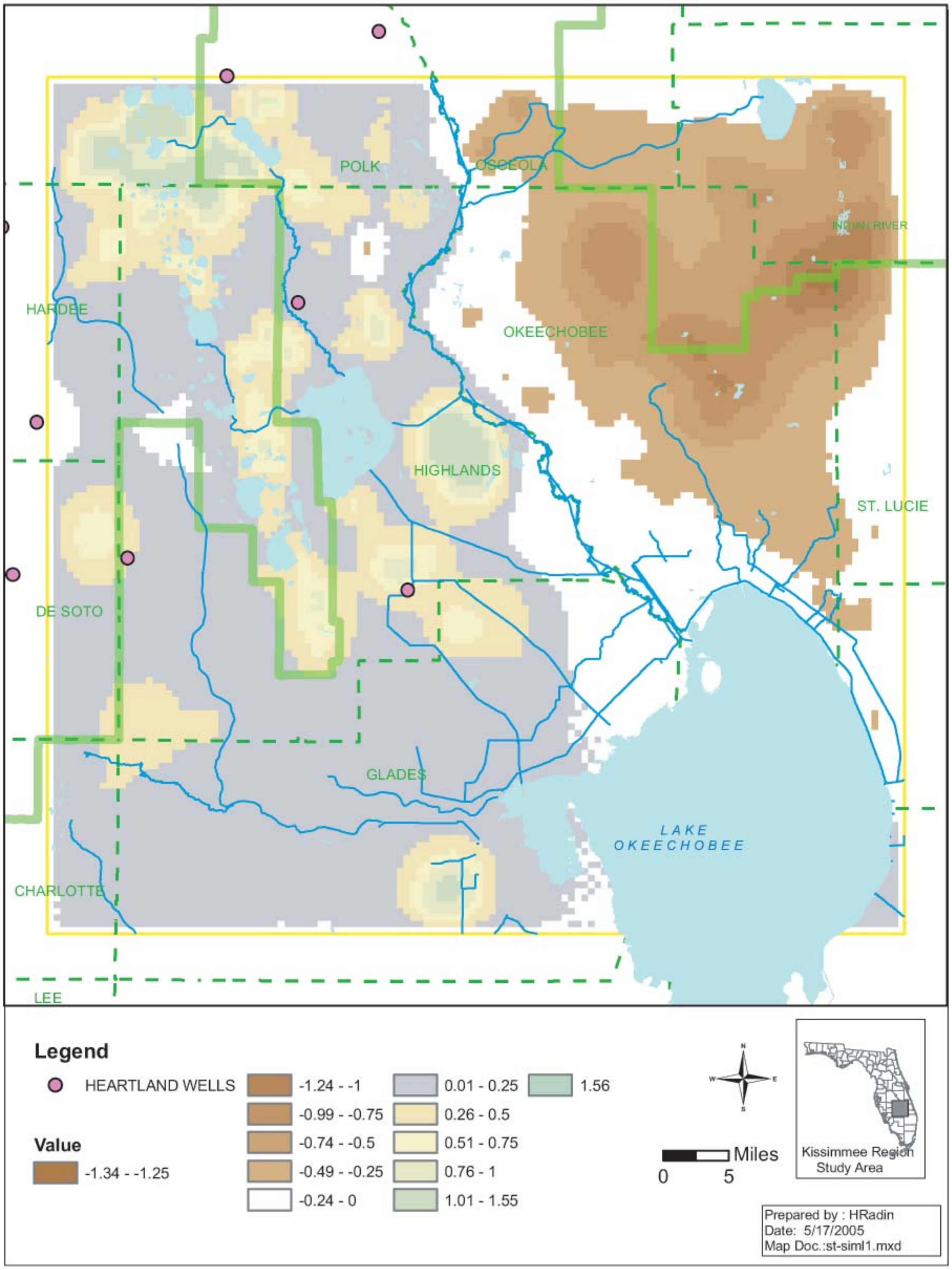

Figure D-36. Difference in Water Levels 1995 1-in-10 and 2025 1-in-10 Middle Floridan Aquifer.

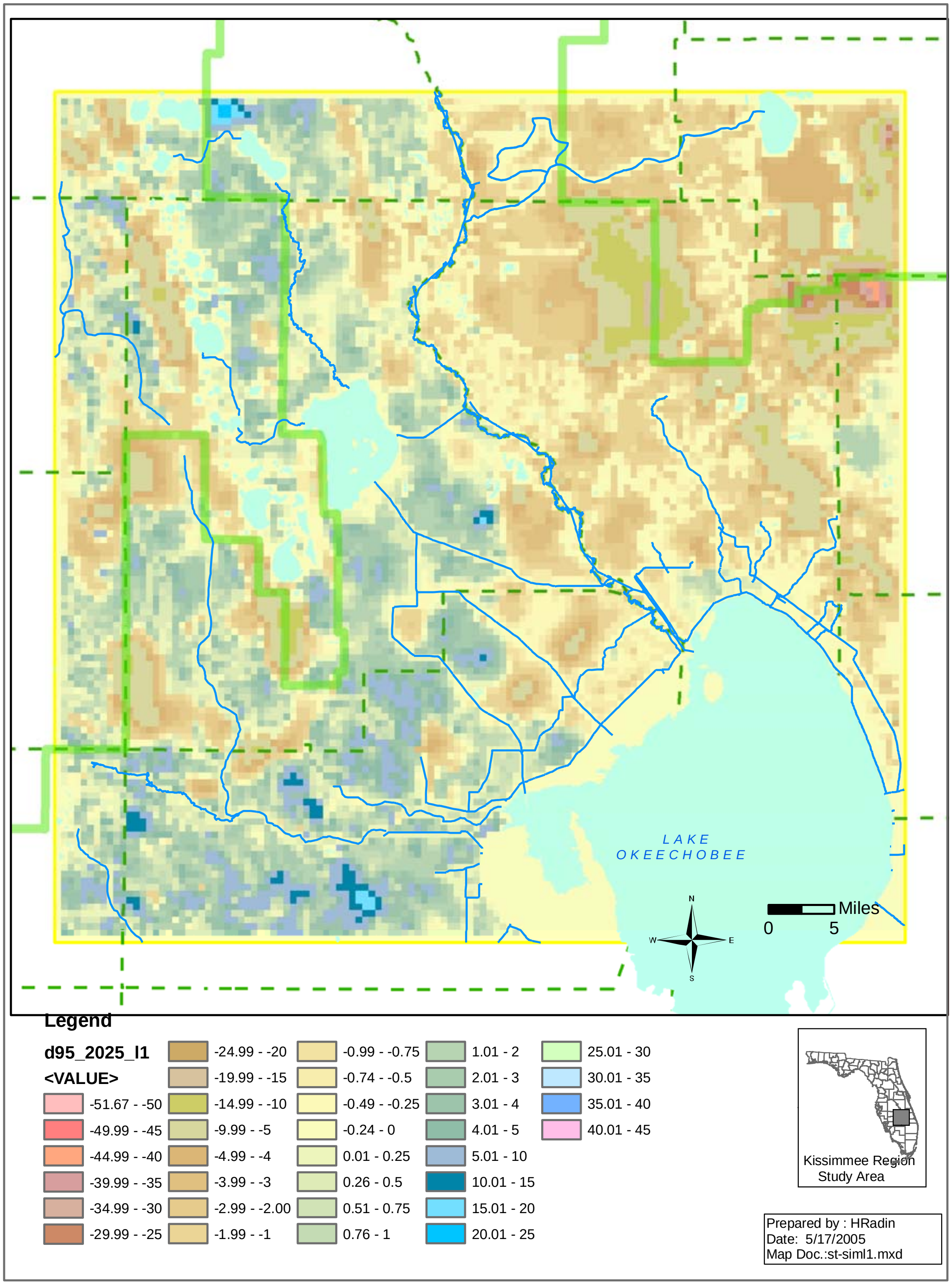

Figure D-37. Difference in Water Levels 1995 1-in-10 and 2025 1-in-10 Surficial Aquifer.

2025 1-in-10 and Well G62

This simulation run uses the same files as the 2025 1-in-10 run with the addition of one more wellfield – G62 in the Upper Floridan Aquifer. For modeling purposes, the proposed wellfield was placed in Layer 2, Row 73 and Column 12. The model assumes that all the consumption is from one well in the center of the cell. This well will pump 2 MGD or 267,400 ft^3/day. The proposed site for G62 places it near the SFWMD/SWFWMD boundary on the Highlands/De Soto county line. The purpose of this simulation is to evaluate the impact of this well on the water levels. This is done by creating drawdown maps, which compare the water levels without well G62 – in this case, the 2025 1-in-10 simulation – to the water levels with the G62 well. The impacts of this simulation are nearly identical to those seen in the 1995 1-in-10 + G62 simulation, and in the 1995 AFSIRS + G62 run. This indicates there is not very much recharge from the Surficial Aquifer System in the area of this proposed well.

The local drawdown in the Upper Floridan Aquifer in cell 2, 73 and 12 is 13.31 feet. One cell away (2,640 feet), the drawdown ranges from 0.5 to 2 feet. At a mile radius, the drawdown decreases to 0.33 feet. For nearly a 10-mile radius there is a drawdown of about 0.25 feet. Half of the drawdown area falls within the SWFWMD (**Figure D-38**).

No impact was seen in the Surficial Aquifer System – the water levels throughout the model changed by a maximum of 0.01 feet (**Figure D-39**).

The Middle Floridan Aquifer showed a drawdown of up to 0.2 feet with the same drawdown cone for a radius of about 3 miles (**Figure D-40**).

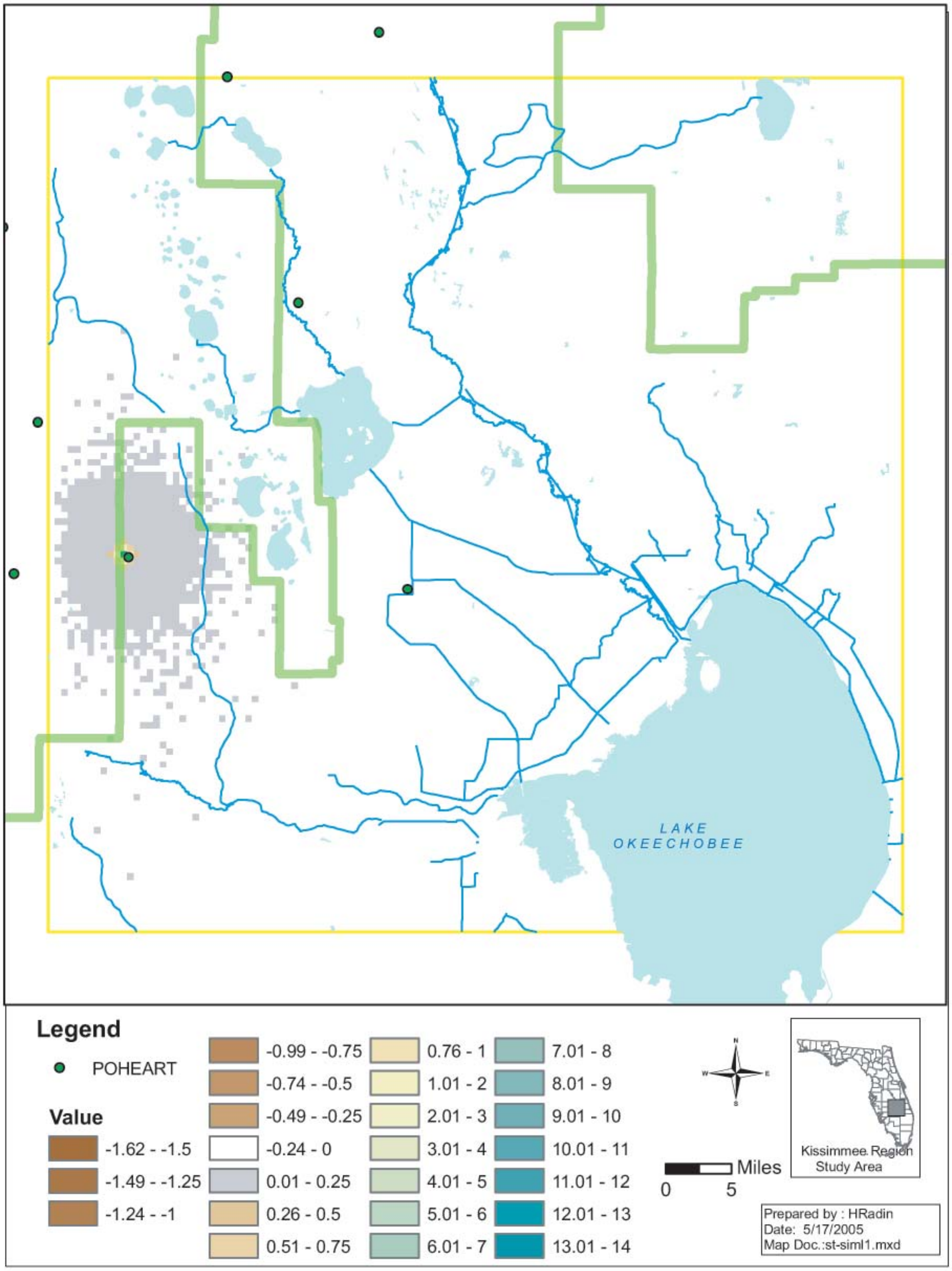

Figure D-38. Difference 2025 – G62 Wellfield Upper Floridan Aquifer.

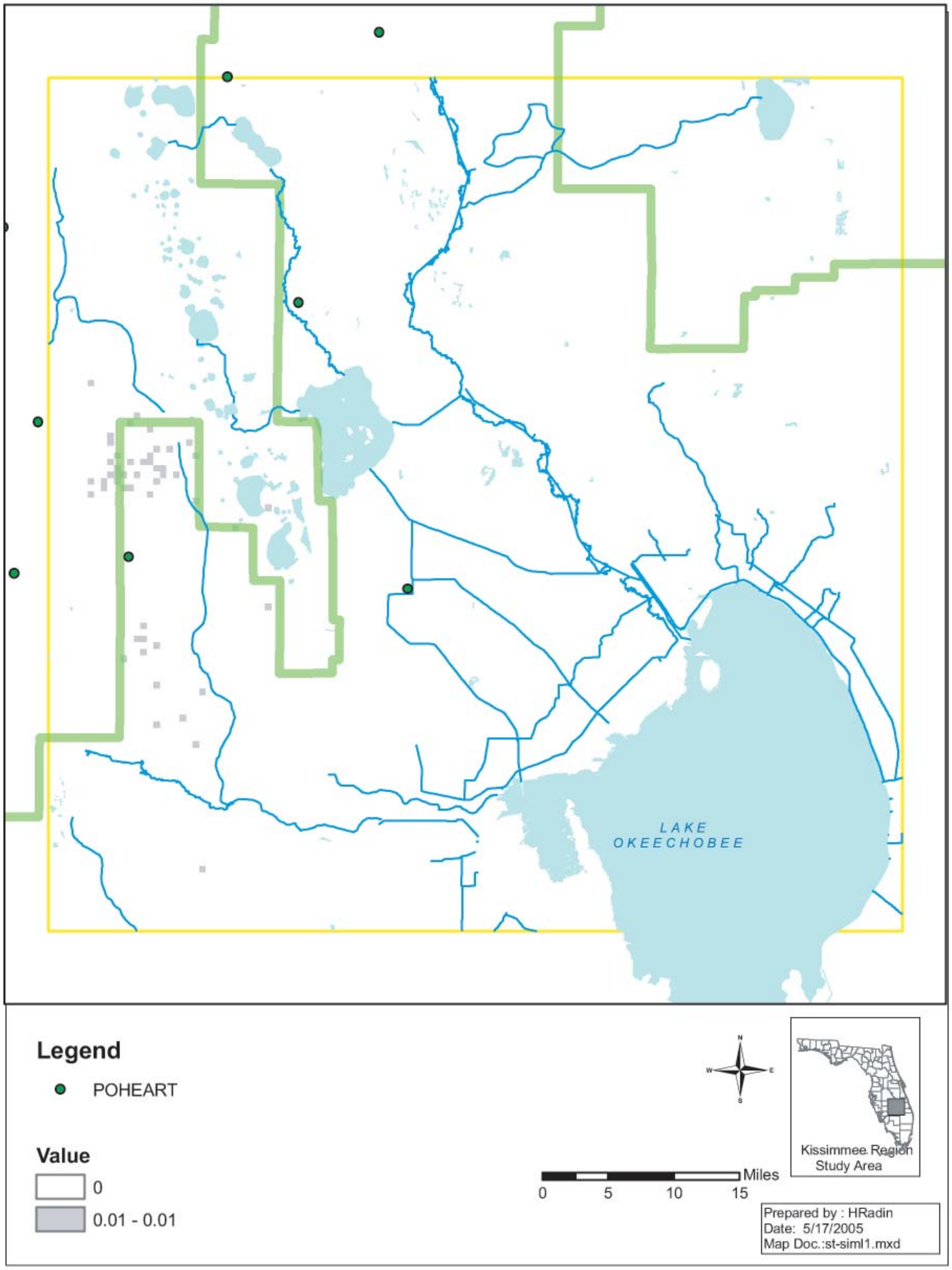

Figure D-39. Difference 2025 – G62 Wellfield Surficial Aquifer.

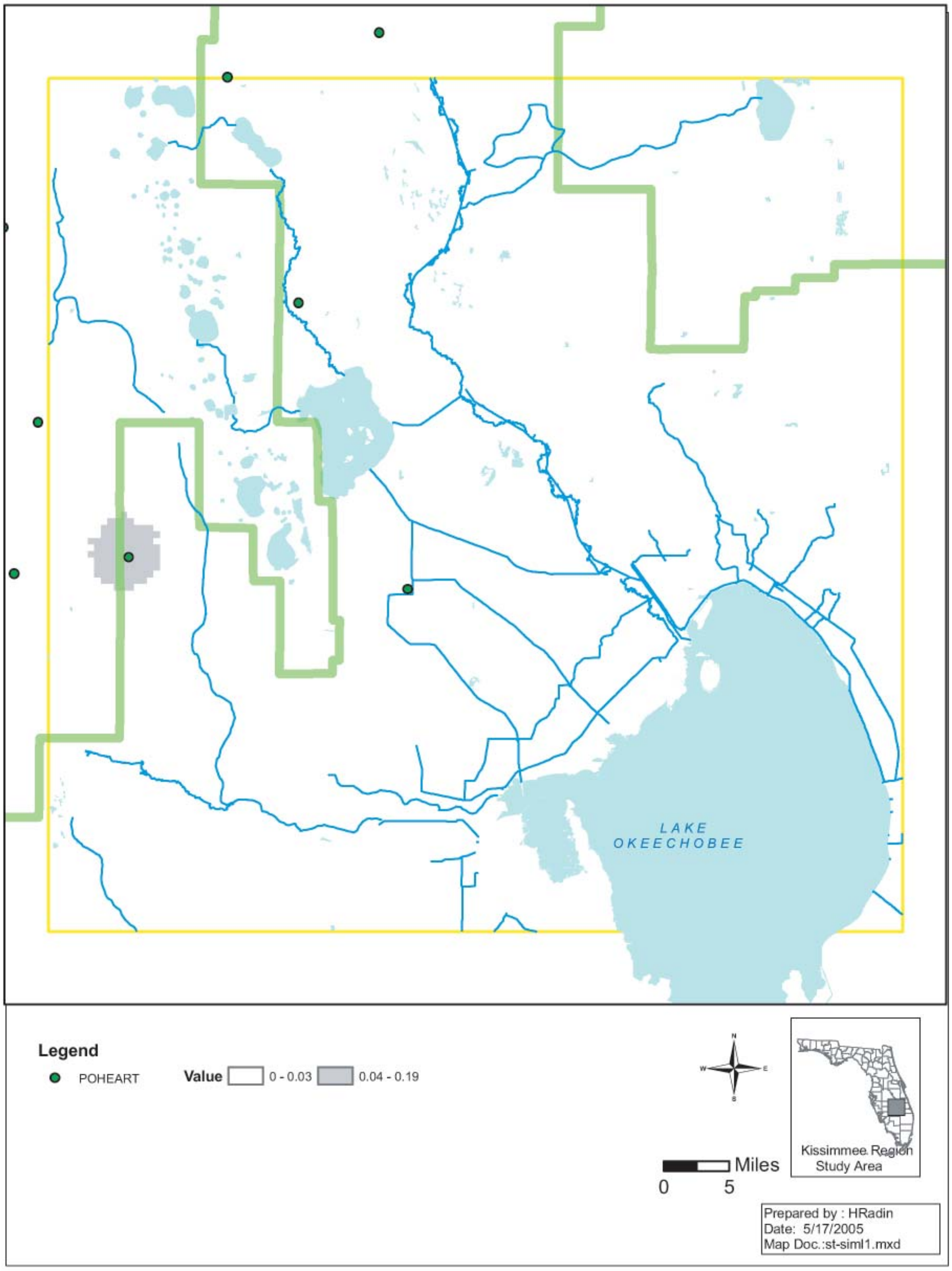

Figure D-40. Difference 2025 – G62 Wellfield Middle Floridan Aquifer.

2025 1-in-10 and Well G63

This simulation run uses the same files as the 2025 1-in-10 Ag run with the addition of one more wellfield – G63 in the Upper Floridan Aquifer. For modeling purposes, the proposed wellfield was placed in Layer 2, Row 34 and Column 38. The model assumes that all the consumption is from one well in the center of the cell. This well will pump 2 MGD or 267,400 ft^3/day. The proposed site for G63 places it in Highlands County near the SFWMD/SWFWMD boundary near Arbuckle Creek, north of Lake Istokpoga. The purpose of this simulation is to evaluate the impact of this well on the water levels. This is done by creating drawdown maps, which compare the water levels without well G63 – in this case, the 2025 1-in-10 Ag run – to the water levels with the G63 well. The impact seen with this simulation is nearly identical to that seen in the 1995 1-in-10 run + G63, and in the 1995 AFSIRS + G63 simulation. This indicates there is not very much recharge from the Surficial Aquifer System in the area of this proposed well.

The local drawdown in the Upper Floridan Aquifer in cell 2, 34 and 38 is 18.29 feet. One cell away (2,640 feet), the drawdown ranges from 0.6 to 1.8 feet. At a mile radius this decreases to 0.25 feet. For nearly a 5-mile radius, there is a drawdown of about 0.25 feet. This area extends into the SWFWMD (**Figure D-41**).

No impact was seen in the Surficial Aquifer System – some cells east of the wellfield changed by a maximum of 0.04 feet. The area with drawdown in the Surficial Aquifer System is larger than in the average 2025 year simulation (**Figure D-42**).

The Middle Floridan Aquifer showed a drawdown of up to 2 feet in cell 3, 34 and 38, a drawdown of 0.75 feet one cell over and drawdowns of up to 0.5 in an area slightly larger than the drawdown cone "footprint," seen in the Upper Floridan Aquifer (**Figure D-43**).

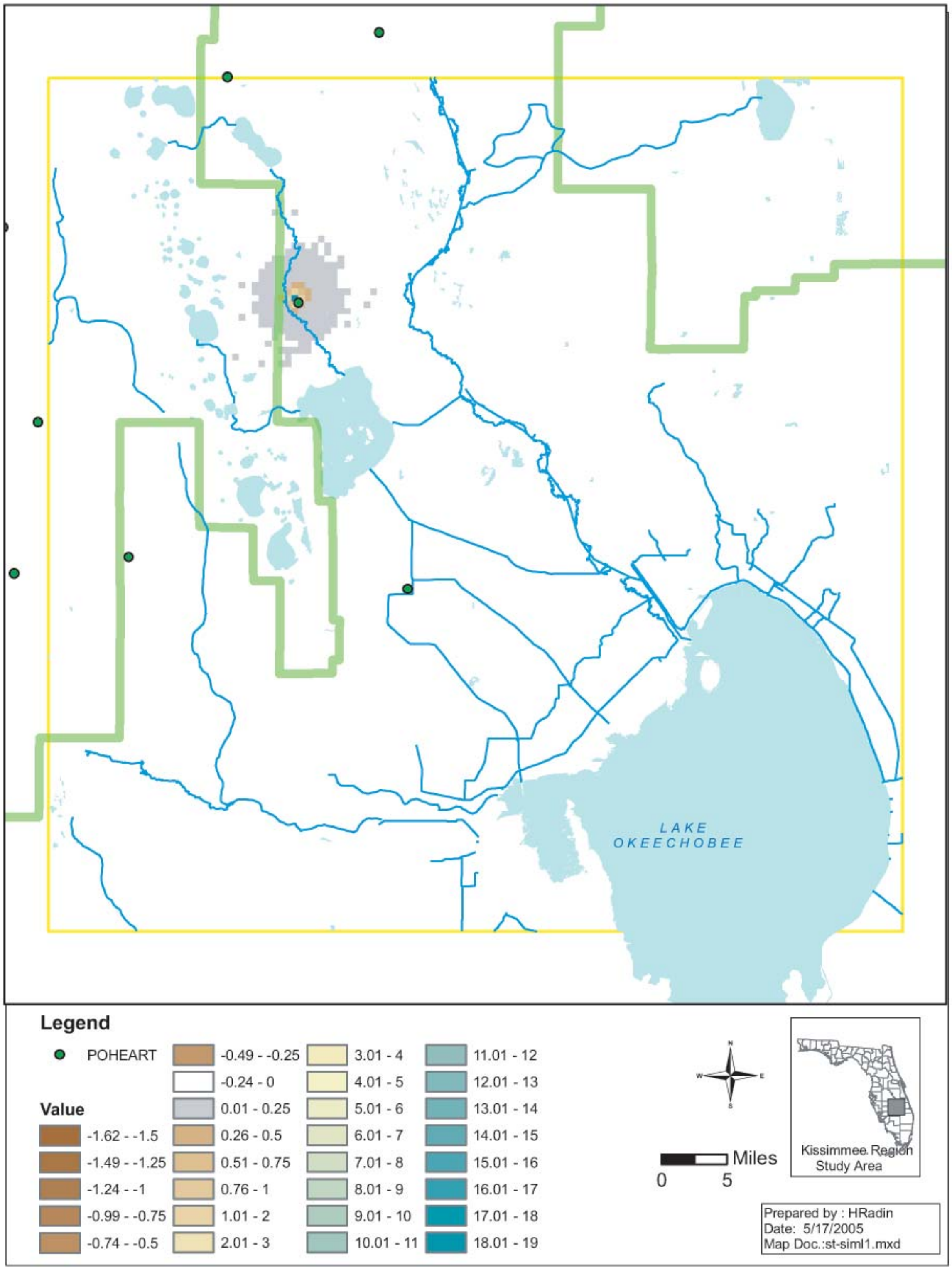

Figure D-41. Difference 2025 – G63 Wellfield Upper Floridan Aquifer.

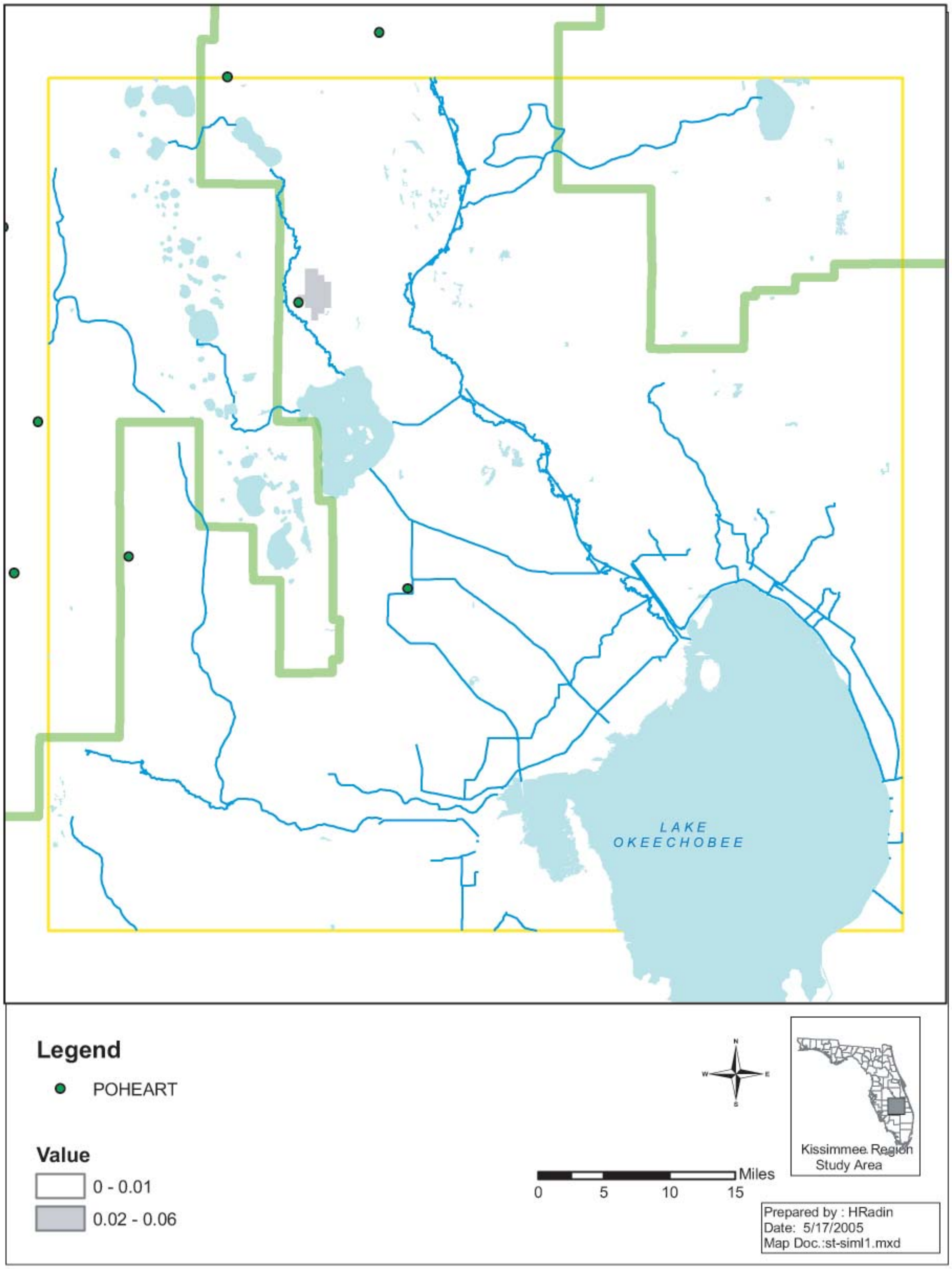

Figure D-42. Difference 2025 – G63 Wellfield Surficial Aquifer.

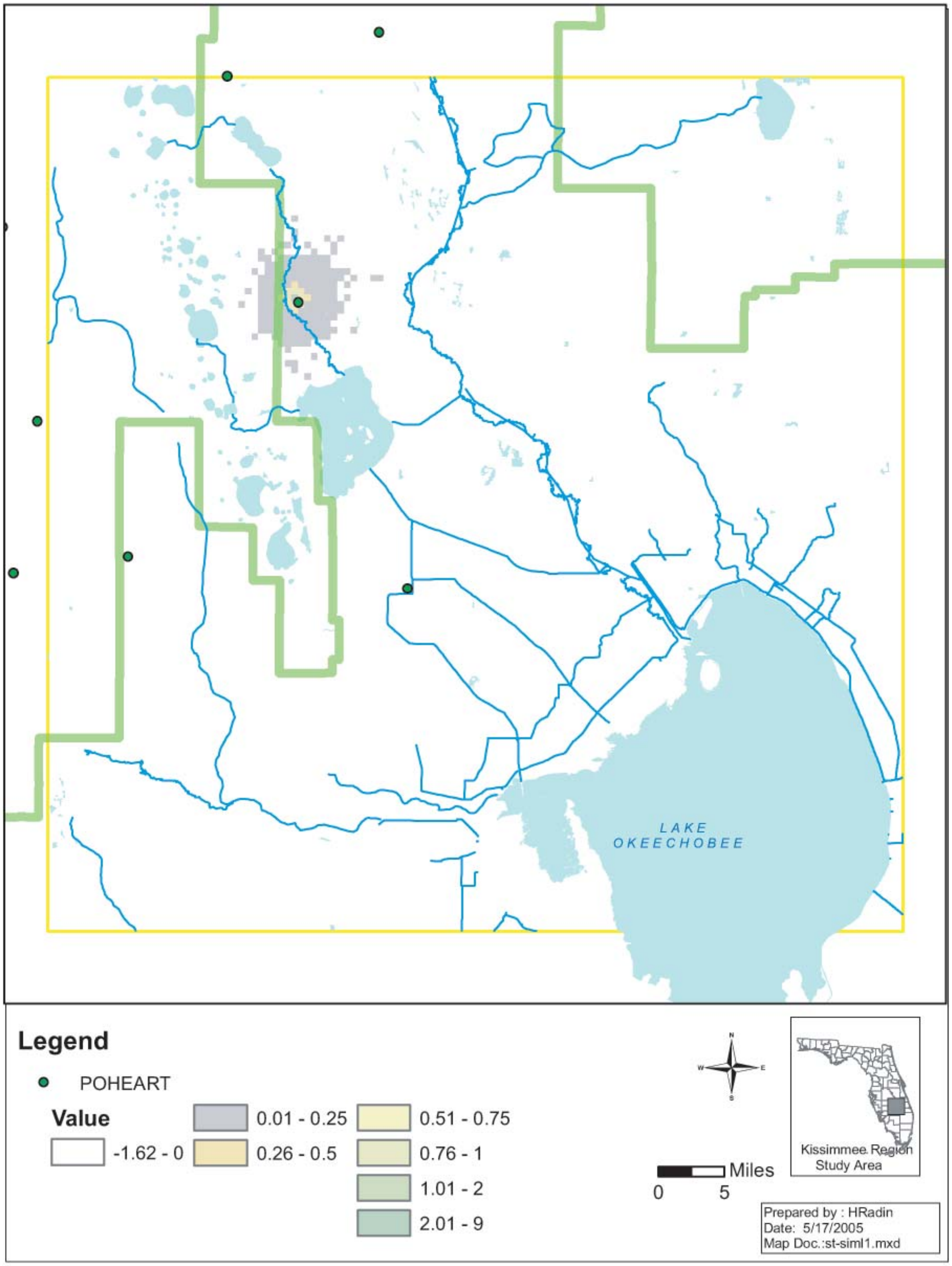

Figure D-43. Difference 2025 – G63 Wellfield Middle Floridan Aquifer.

2025 1-in-10 and Well G64

This simulation run uses the same files as the 2025 1-in-10 run with the addition of one more wellfield – G64 in the Upper Floridan Aquifer. For modeling purposes, the proposed wellfield was placed in Layer 2, Row 77 and Column 55. The model assumes that all the consumption is from one well in the center of the cell. This well will pump 5 MGD or 668,500 ft^3/day. The proposed site for G64 places it in Highlands County near the C-41 Canal. The purpose of this simulation is to evaluate the impact of this well on the water levels. This is done by creating drawdown maps, which compare the water levels without well G64 – in this case, the 2025 1-in-10 run – to the water levels with the G64 well. The impacts seen with this simulation are nearly identical to those seen in the 1995 1-in-10 run with well G64, and in the 1995 AFSIRS + G64 simulation. This indicates there is not very much recharge from the Surficial Aquifer System in the area of this proposed well.

The local drawdown in the Upper Floridan Aquifer in cell 2, 77 and 55 is 25.63 feet. One cell away (2,640 feet), the drawdown ranges from 2 to 5 feet. At a mile away, this decreases to 0.8–1.3 feet. At a 1.5-mile radius, the drawdown decreases to 0.5 feet. For about an 8-mile radius, there is a drawdown of about 0.25 feet. This area extends into the SWFWMD (**Figure D-44**).

No impact was seen in the Surficial Aquifer System – the water levels in a few scattered cells changed by up to 0.1 feet (**Figure D-45**).

The Middle Floridan Aquifer showed a drawdown of up to 1.18 feet in cell 3, 77 and 55, a 0.5-foot drawdown for the next mile, then up to 0.25 feet of drawdown in the area of the drawdown cone "footprint," seen in the Upper Floridan Aquifer (**Figure D-46**).

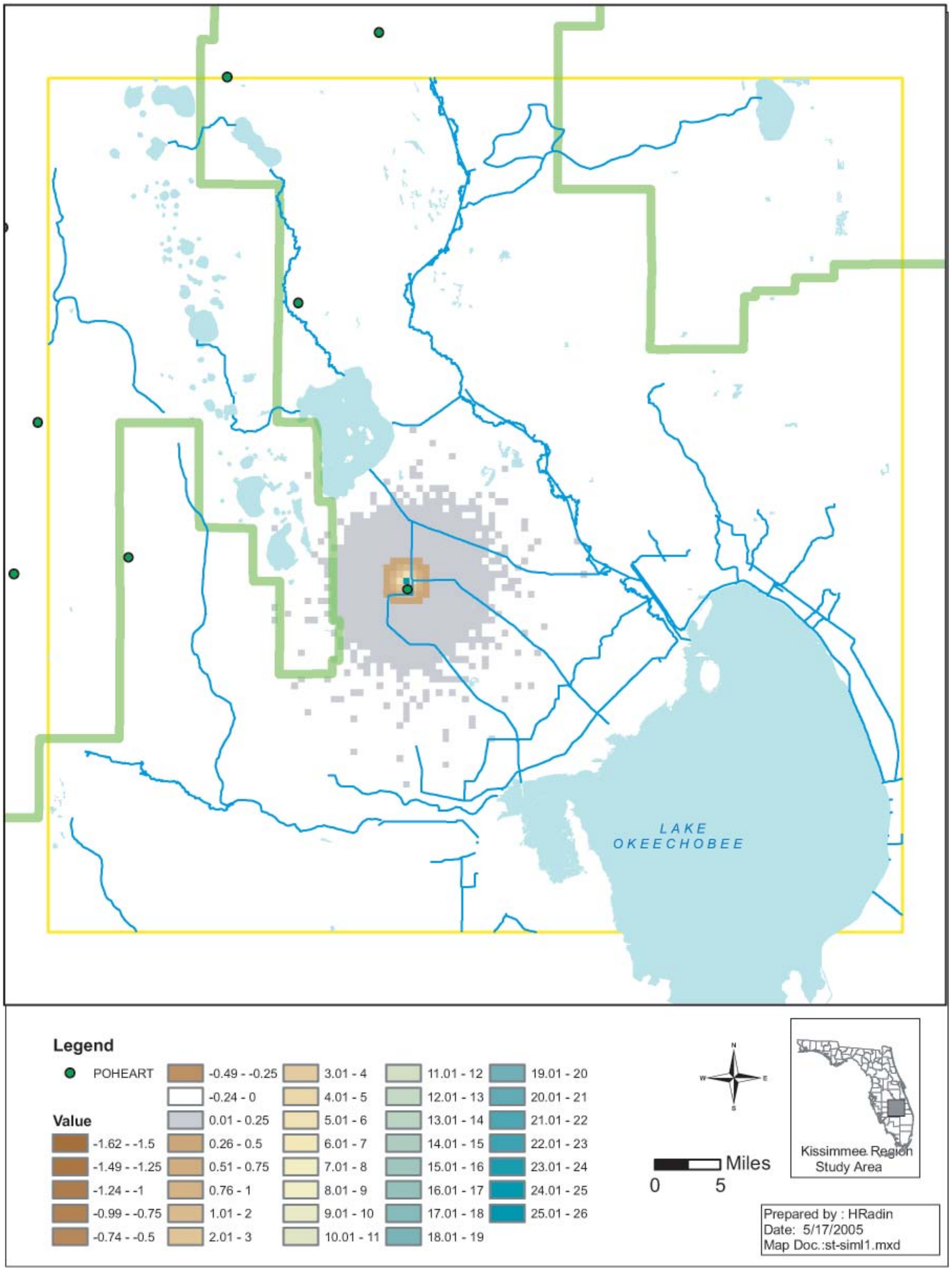

Figure D-44. Difference 2025 – G64 Wellfield Upper Floridan Aquifer.

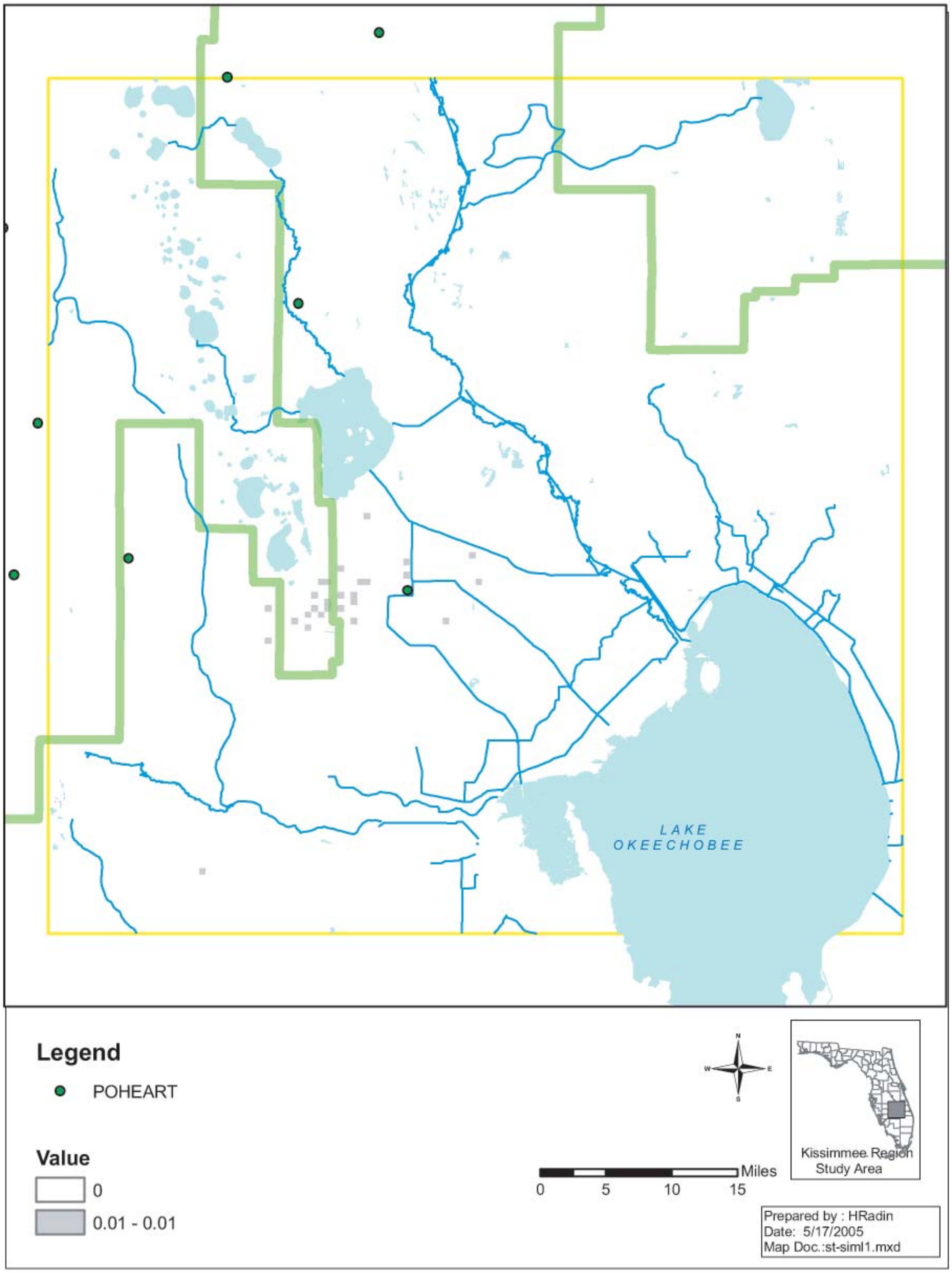

Figure D-45. Differences 2025 – G64 Wellfield Surficial Aquifer.

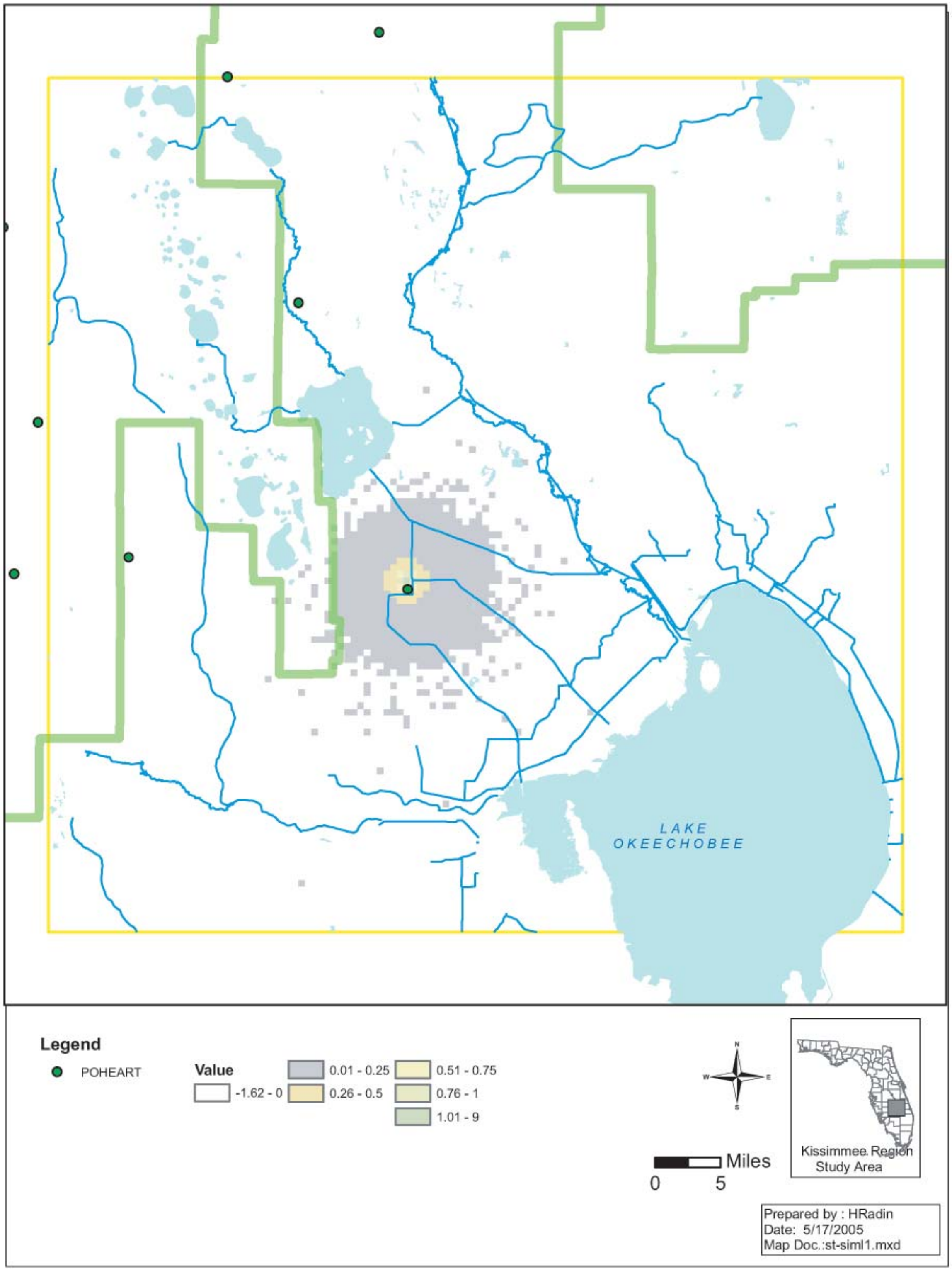

Figure D-46. Differences 2025 – G64 Wellfield Middle Floridan Aquifer.

ALTERNATIVE SIMULATIONS

As most of consumptive use wells in the proposed areas are located in the Middle Floridan Aquifer and not the Upper Floridan Aquifer, therefore location of the wells may need to be reconsidered. The thickness of the Upper Floridan Aquifer in the proposed areas is only 100 feet at G62 and 135 feet at G63 and G64 and the Middle Semi-Confining Unit 1, is 550–650 feet thick in these locations. The transmissivity at G62 in the Middle Floridan Aquifer is 586,000 ft^2/day, at G63 37,000 ft^2/day and at G64 162,000 ft^2/day. In the Upper Floridan Aquifer, the transmissivities at these locations were 2,800 ft^2/day, 1,000 ft^2/day and 4,900 ft^2/day respectively. This would make the production rates of 2 to 5 MGD at these sites in the Upper Floridan unlikely to be obtained and sustained.

The very high transmissivity value for the Middle Floridan Aquifer in Desoto County comes solely from one APT at ROMP 12 Prairie Creek. The SWFWMD got a value of 1,640,000 ft^2/day from their pump test on this zone (Reese and Richardson 2004). This site is nearest to the proposed site for G62.

For the following simulations the proposed wellfields were modeled in the Middle Floridan Aquifer.

Table D-7. Assumptions on Wellfields.

Well	Layer	Row	Column	MGD*	Ft^3/day
G62	3	73	12	2.00	267,400.00
G63	3	34	38	2.00	267,400.00
G64	3	77	55	5.00	668,500.00

* Millions Gallons per day.

1995 AFSIRS Ag with Wellfields in Middle Floridan Aquifer

For this model run, the consumptive use in the agricultural wells was estimated based on AFSIRS calculations for the land use. The three wellfields G62, G63 and G64 were all placed in Layer 3 in the Middle Floridan Aquifer. Impacts were seen to both the Middle Floridan Aquifer and to the Upper Floridan Aquifer.

As seen in **Figure 47**, in the Middle Floridan Aquifer at G62, the drawdown was 0.26 feet. For a radius of 8 miles the drawdown was up to 0.25 feet. At G63 the drawdown was 2.41 feet. At a mile distance the drawdown decreases to 0.5–0.8 feet. For about a 5-mile radius, there is a drawdown of about 0.25 feet. At G64 the drawdown is 1.89 feet. At a mile distance the drawdown decreases to 0.8, and at 2 miles distance to 0.5 feet. For about a 7-mile radius, there is a drawdown of about 0.25 feet.

The drawdowns in the Upper Floridan Aquifer (**Figure D-48**) have a similar “footprint” to those in the Middle Floridan Aquifer. At G64 the drawdown is 1.18 feet and at G63 the drawdown is 2.02 feet. All other cells have a drawdown within 0.03 feet of those seen in the Middle Floridan Aquifer.

The drawdown in the Surficial Aquifer System (**Figure D-49**) is minimal with the most change seen near G63, where there is a drawdown of up to 0.04 feet.

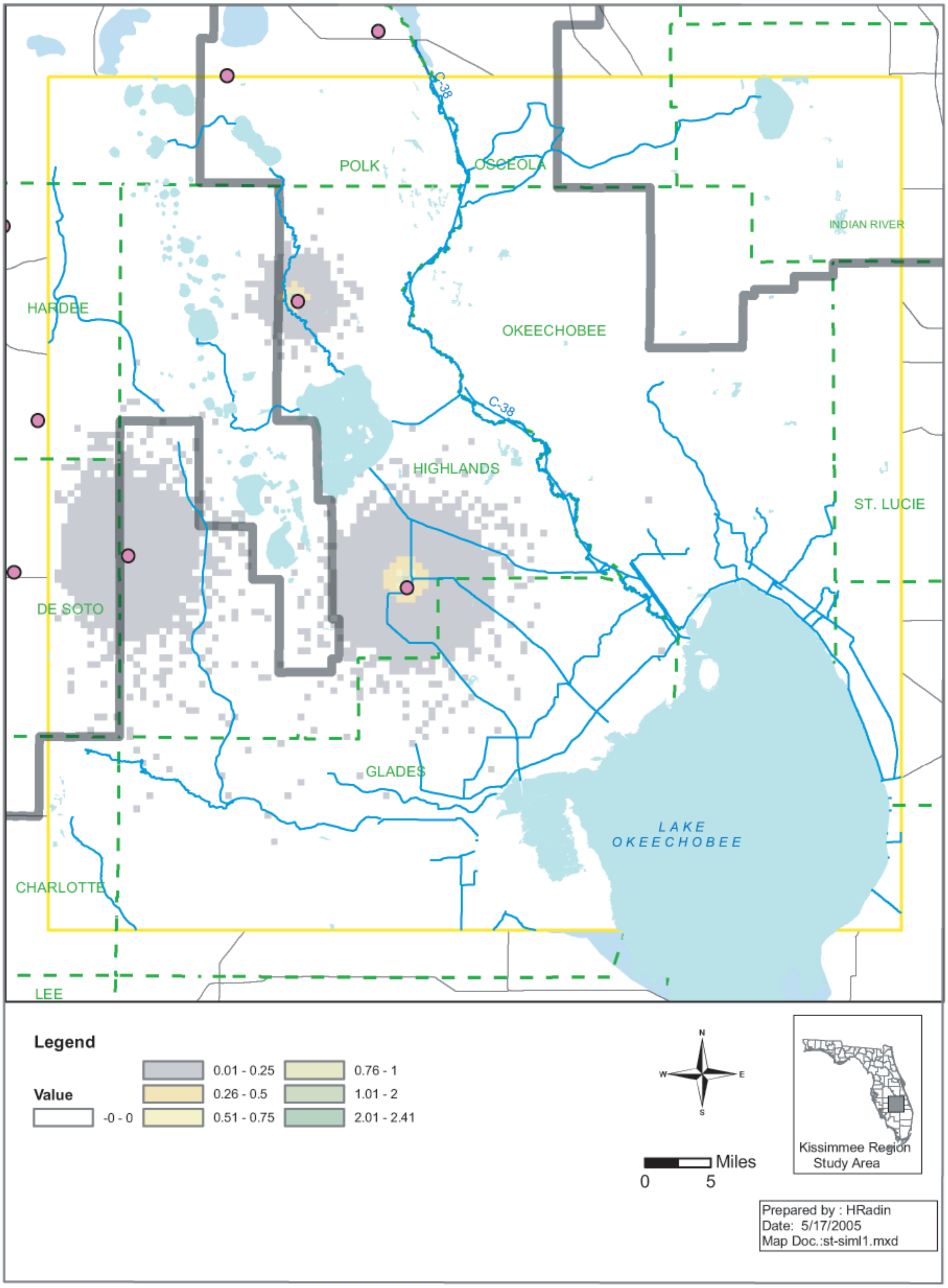

Figure D-47. Drawdown (feet) in Middle Floridan Aquifer – 1995 AFSIRS Ag with Wellfields G62, G63 and G64 in Middle Floridan Aquifer.

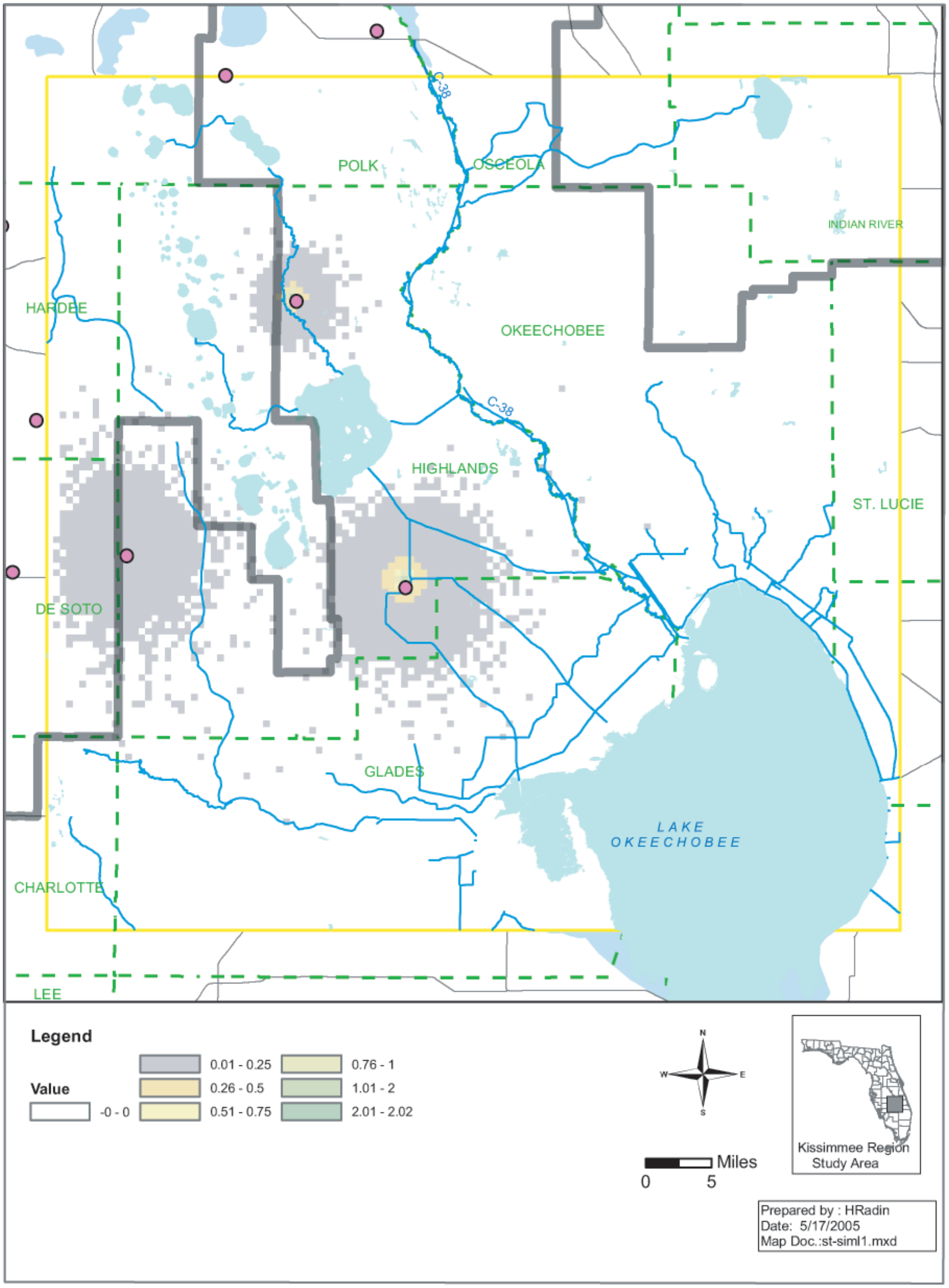

Figure D-48. Drawdown (feet) in Upper Floridan Aquifer – 1995 AFSIRS Ag with Wellfields G62, G63 and G64 in Middle Floridan Aquifer.

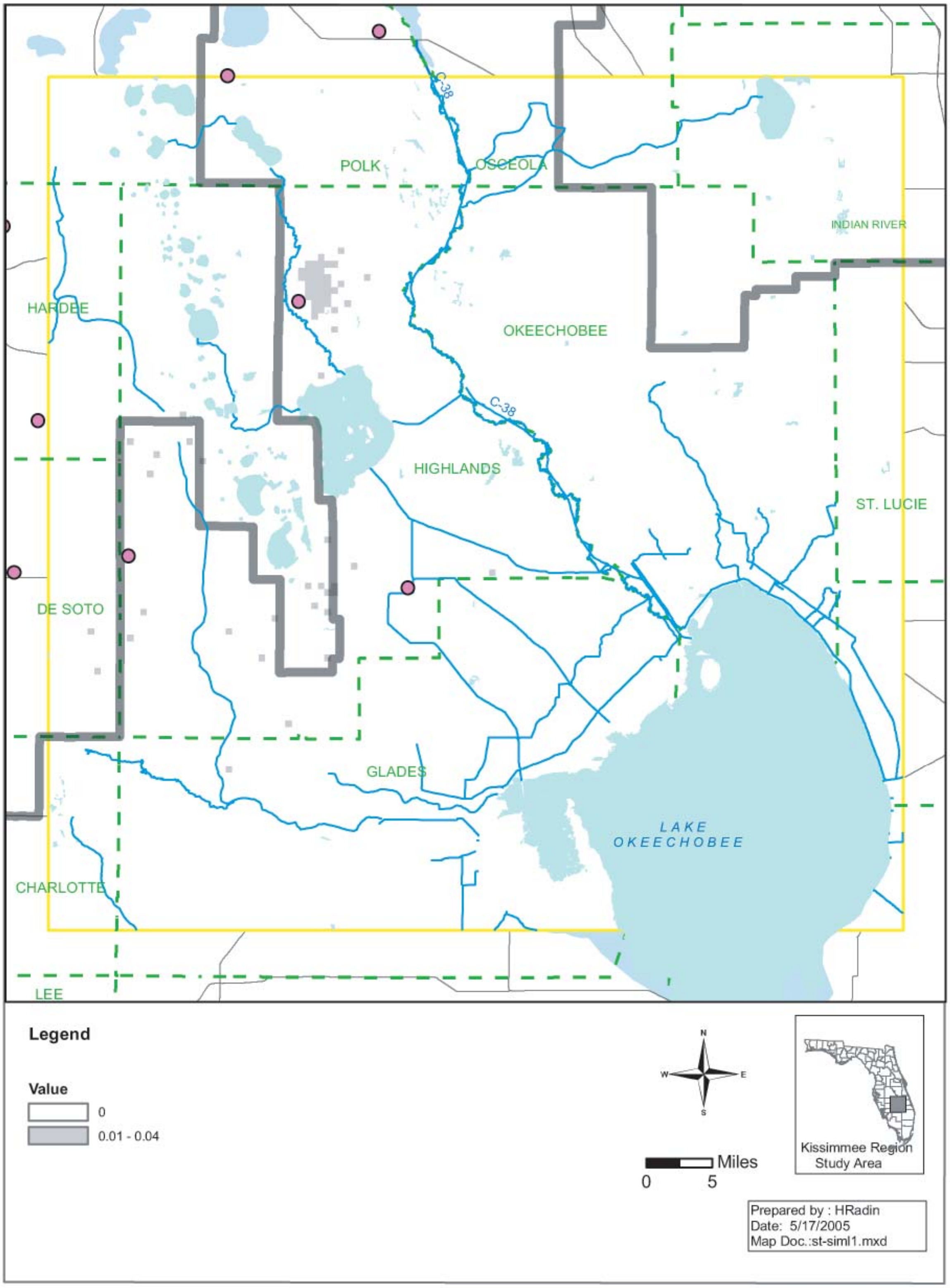

Figure D-49. Drawdown (feet) in Surficial Aquifer – 1995 AFSIRS Ag with Wellfields G62, G63 and G64 in Middle Floridan Aquifer.

1995 1-in-10 with Wellfields in Middle Floridan Aquifer

The 1995 1-in-10 simulation run used the same files as the 1995 AFSIRS run, with the exception of the Evapotranspiration, Recharge and Agriculture consumption well files. These files were modified for the 1-in-10 rainfall conditions. These files are still based on the 1995 land use conditions. Three wellfields were added to these files. Wellfields G62, G63 and G64 were all placed in Layer 3 in the Middle Floridan Aquifer.

The impacts of the wellfields are the same (less than 0.01 feet difference in water levels between simulation runs) as those previously seen in the 1995 AFSIRS Ag with wellfields (**Figures 50–52**).

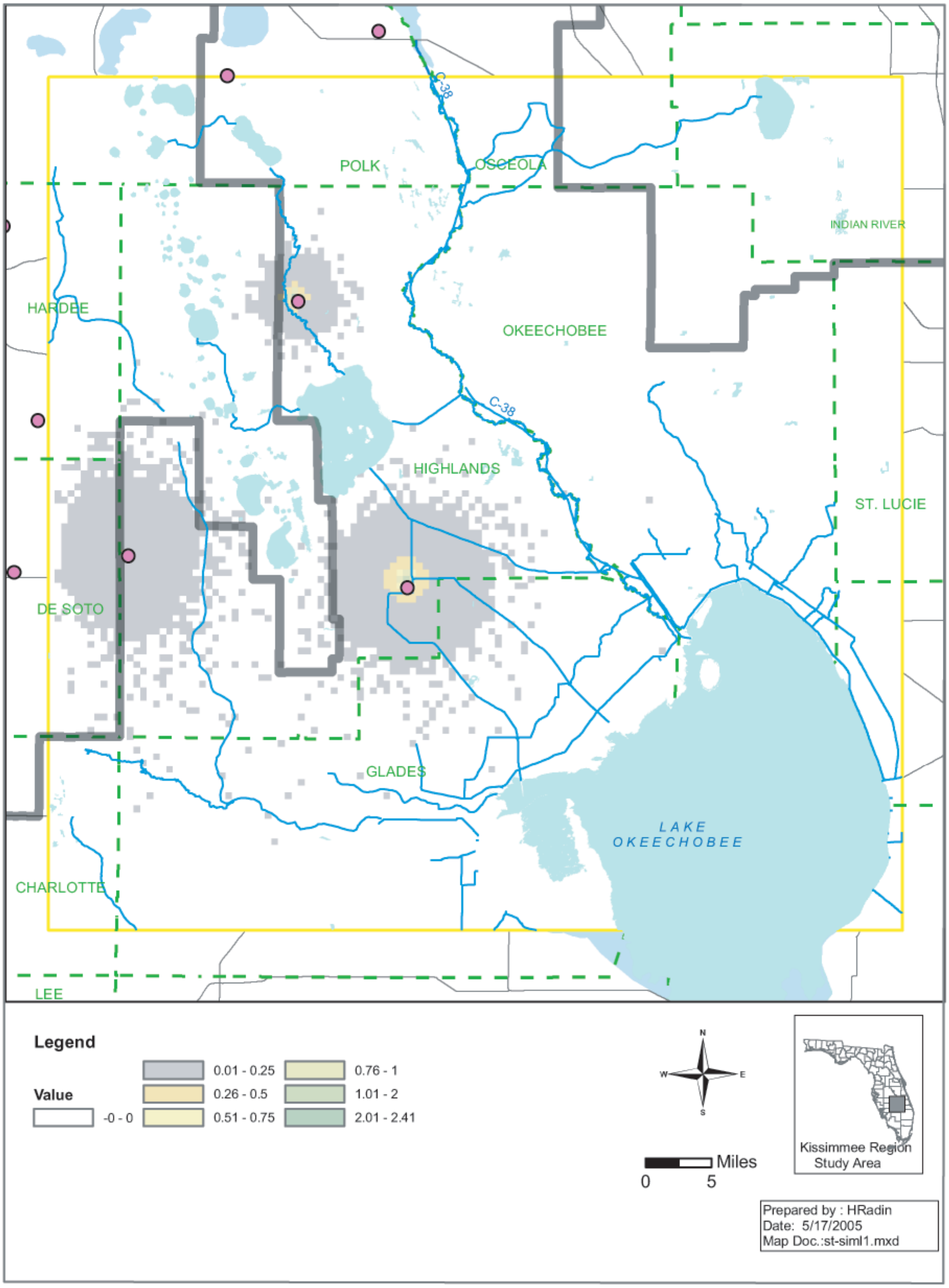

Figure D-50. Drawdown (feet) in Middle Floridan Aquifer – 1995 AFSIRS 1-in-10 with Wellfields G62, G63 and G64 in Middle Floridan Aquifer.

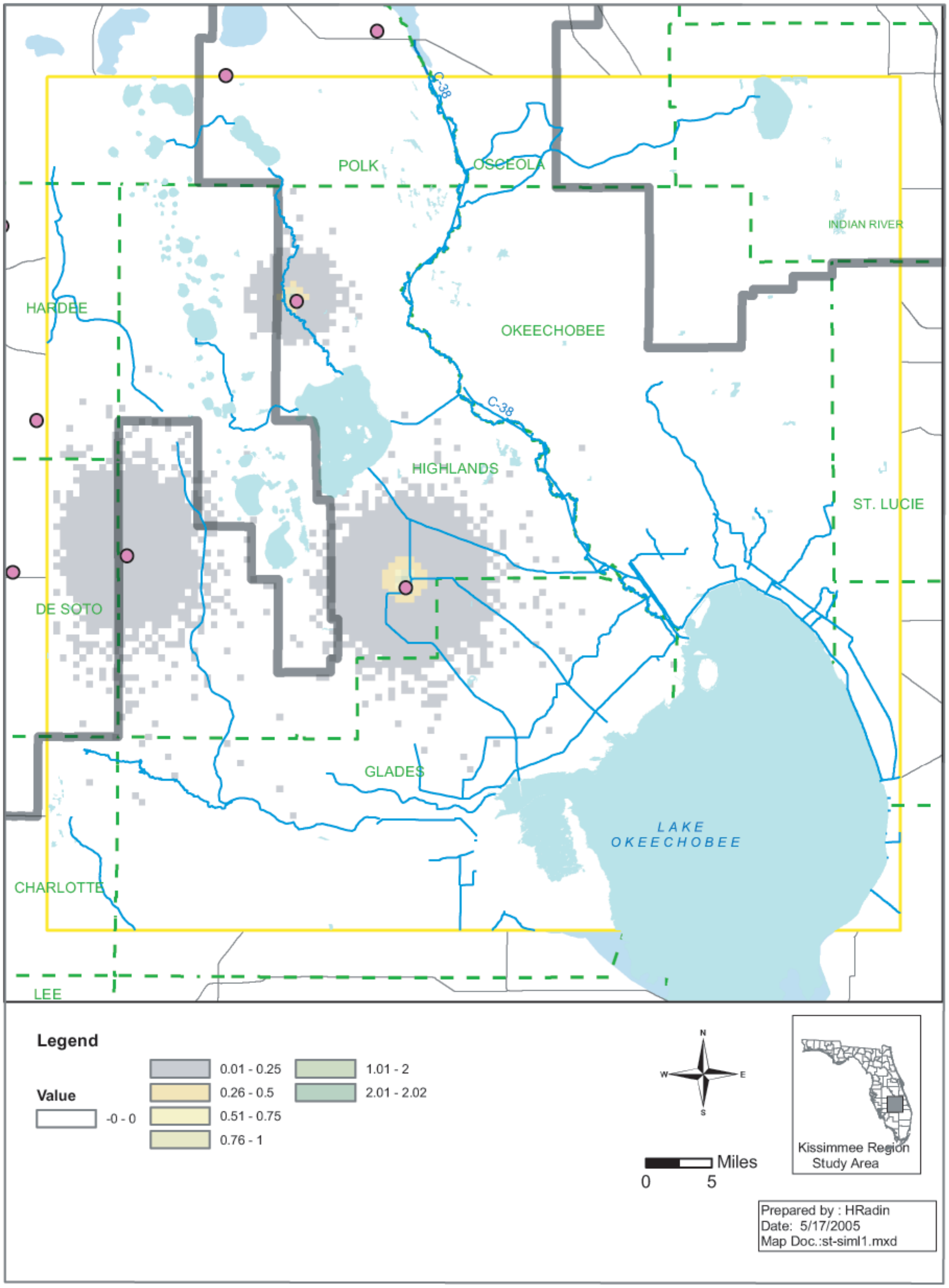

Figure D-51. Drawdown (feet) in Upper Floridan Aquifer – 1995 1-in-10 with Wellfields G62, G63 and G64 in Middle Floridan Aquifer.

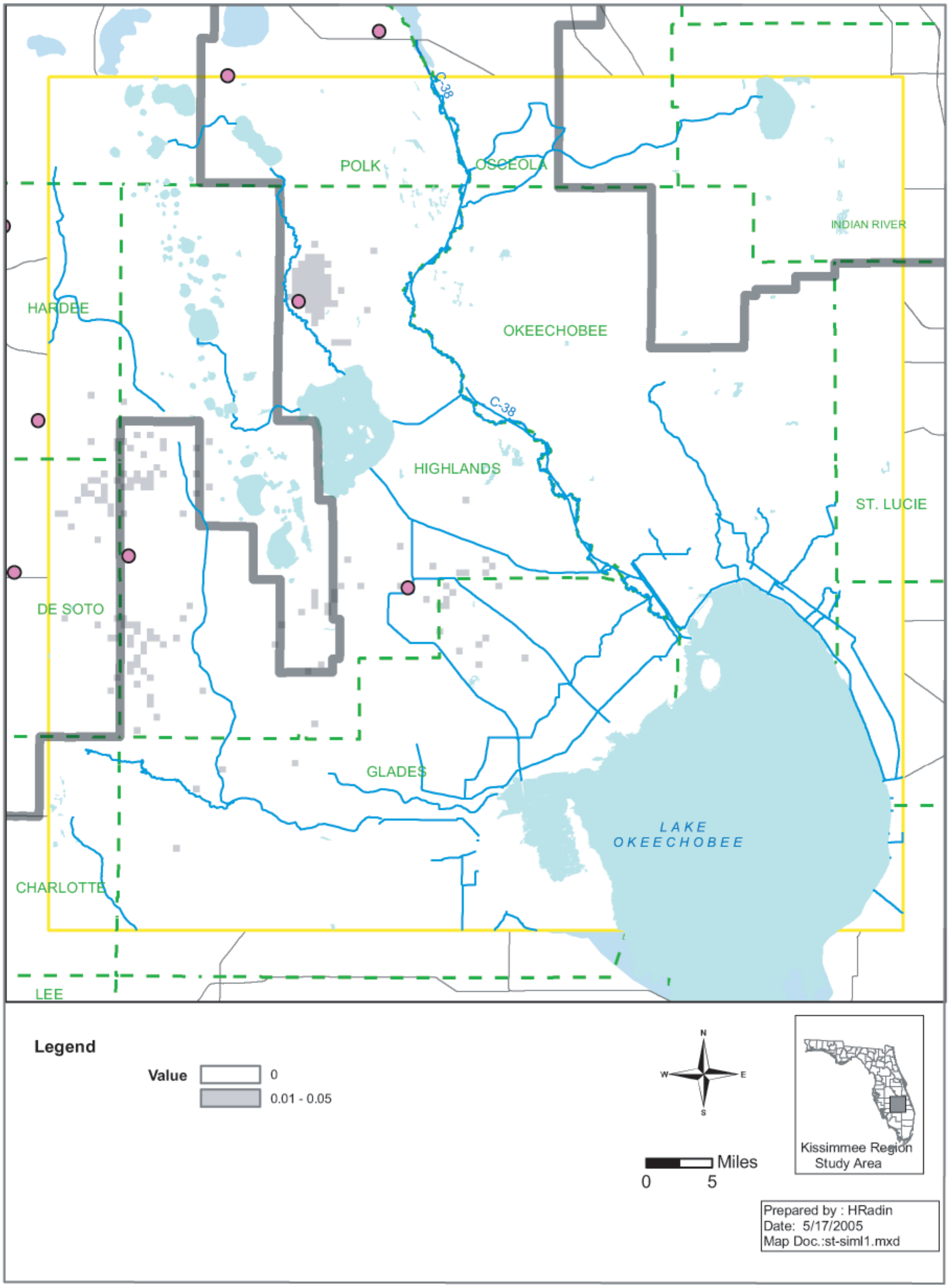

Figure D-52. Drawdown (feet) in Surficial Aquifer – 1995 1-in-10 with Wellfields G62, G63 and G64 in Middle Floridan Aquifer.

2025 1-in-10 with Wellfields in Middle Floridan Aquifer

This simulation run uses the same files as the 2025 1-in-10 run with the addition of the three wellfields. Wellfields G62, G63 and G64 were all placed in Layer 3 in the Middle Floridan Aquifer. The impacts of the wellfields are the same (less than 0.01 feet difference in water levels between simulation runs) as those previously seen in the 1995 AFSIRS Ag with wellfields (**Figure 53–55**).

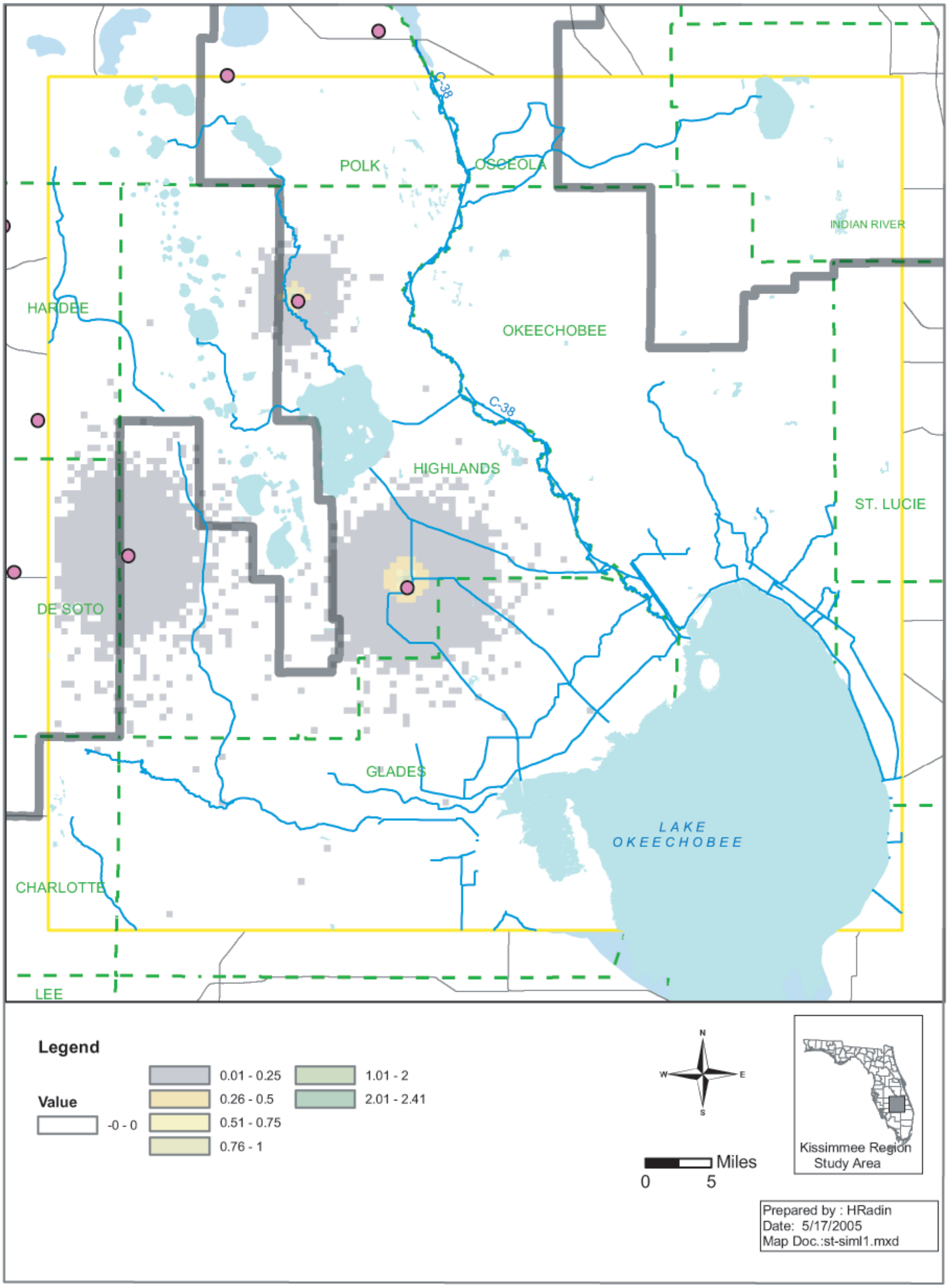

Figure D-53. Drawdown (feet) in Middle Floridan Aquifer – 2025 1-in-10 with Wellfields G62, G63 and G64 in Middle Floridan Aquifer.

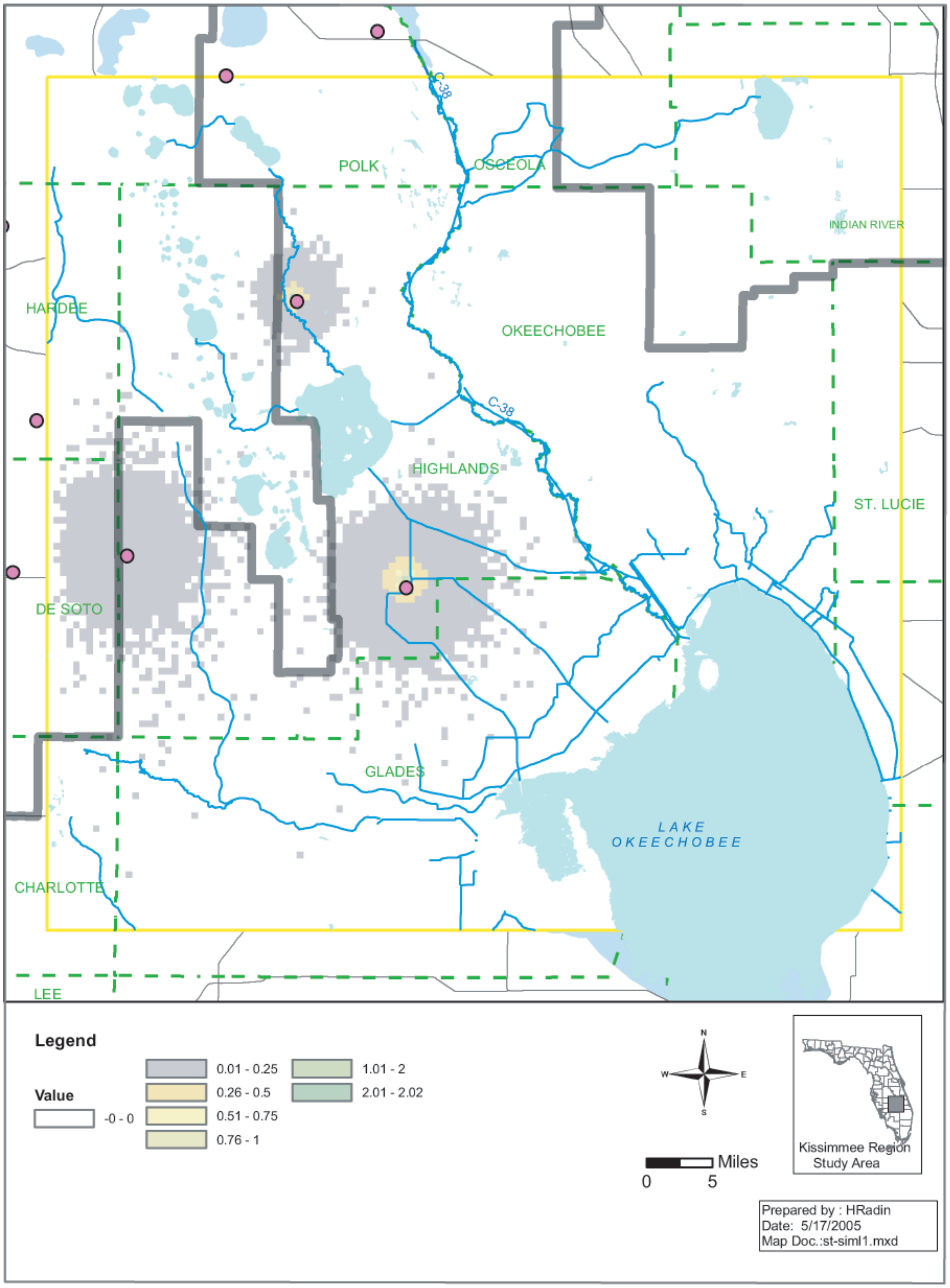

Figure D-54. Drawdown (feet) in Upper Floridan Aquifer – 2025 1-in-10 with Wellfields G62, G63 and G64 in Middle Floridan Aquifer.

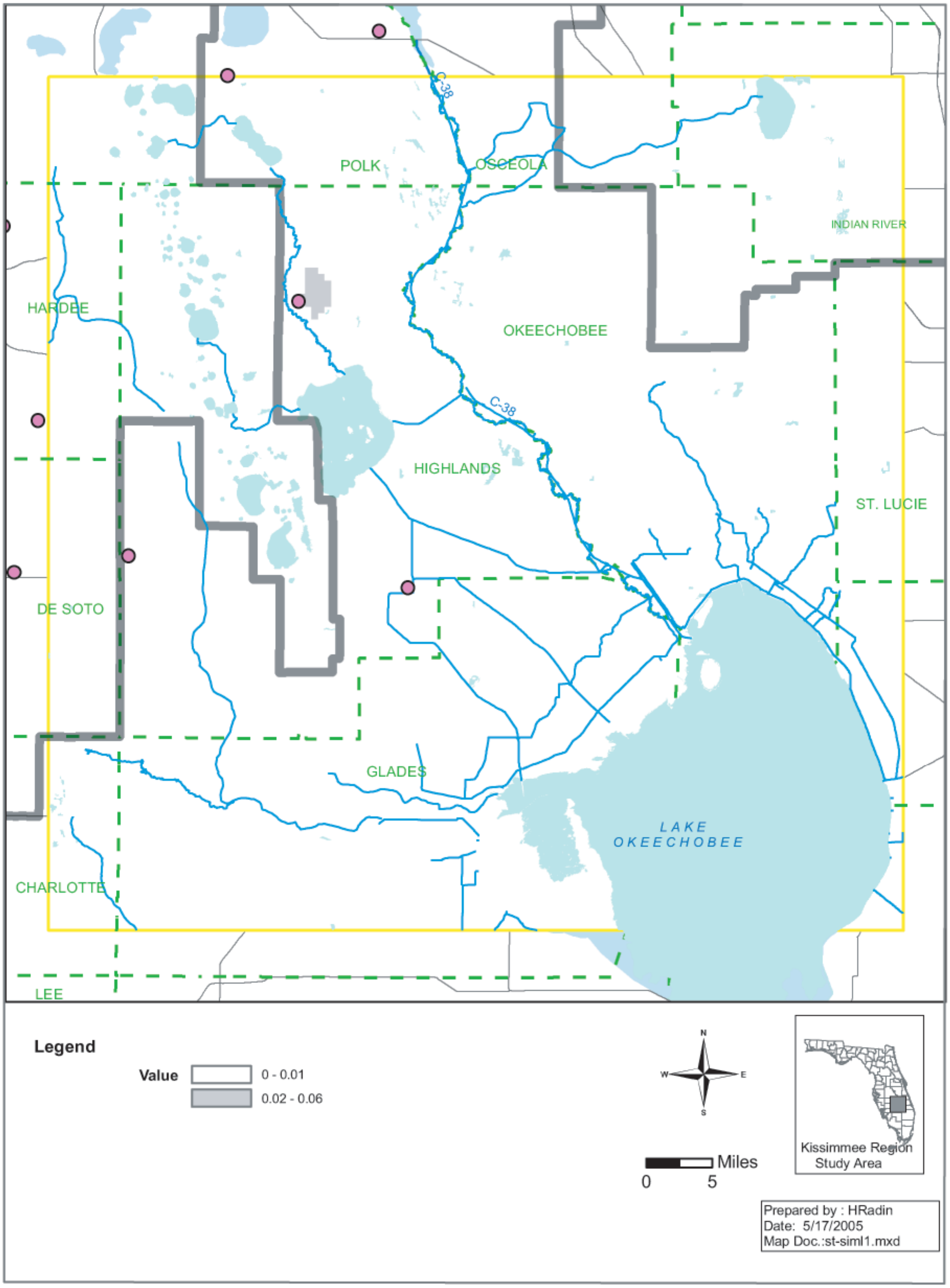

Figure D-55. Drawdown (feet) in Surficial Aquifer – 2025 1-in-10 with Wellfields G62, G63 and G64 in Middle Floridan Aquifer.

NO WELLS RUN

Two simulations were conducted with the wells turned off – 1995 1-in-10 and 2025 1-in-10. These runs were conducted to evaluate the impact of the changing land use from 1995 to 2025.

The Surficial Aquifer was impacted the most by the changes in land use (**Figure D-56**). In east Okeechobee and northwest St. Lucie counties, the water levels in 2025 were up to 44 feet higher in 2025. In most of the model area, the water levels in 2025 were within 5 feet of the water levels observed with the 1995 simulation. West of the Kissimmee River, except for west of Lake Wales Ridge, the water levels were lower in 2025 than in 1995.

In the Upper Floridan Aquifer, most water levels changed by less than 0.25 feet (**Figure D-57**). In eastern Okeechobee County, and in portions of the Avon Park Bombing Range, the water levels were higher by up to 2 feet in 2025. In the Fisheating Creek region, the water levels were up to 0.5 feet lower in 2025.

Most of the Middle Floridan Aquifer showed no water level changes between the two runs (**Figure D-58**). Only the area in east Okeechobee County was higher by up to 0.9 feet in 2025. Polk County water levels were lower by up to 1.26 feet in 2025.

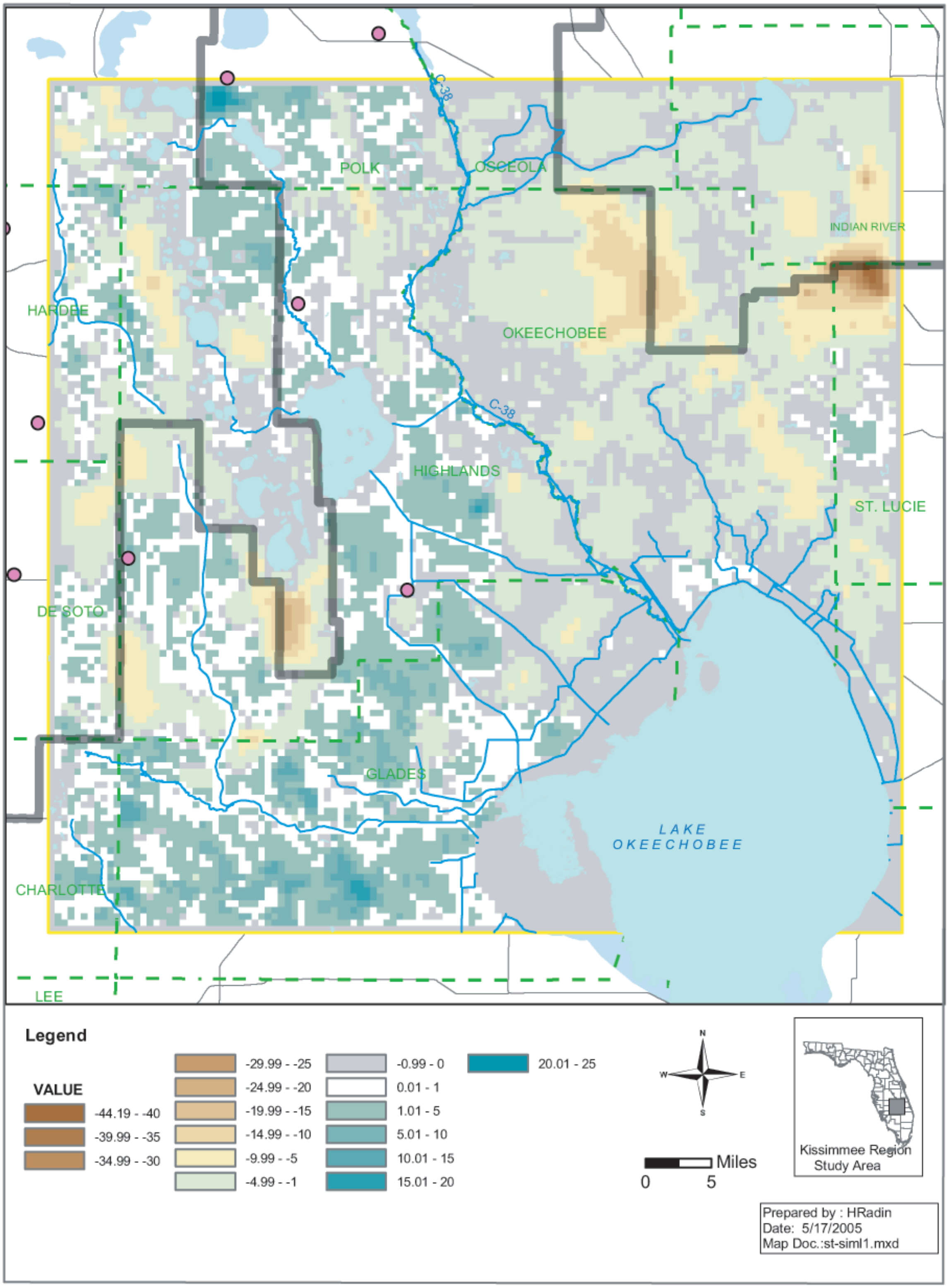

Figure D-56. Drawdown (feet) in Surficial Aquifer – 1995 1-in-10 and 2025 1-in-10 with Wells Off.

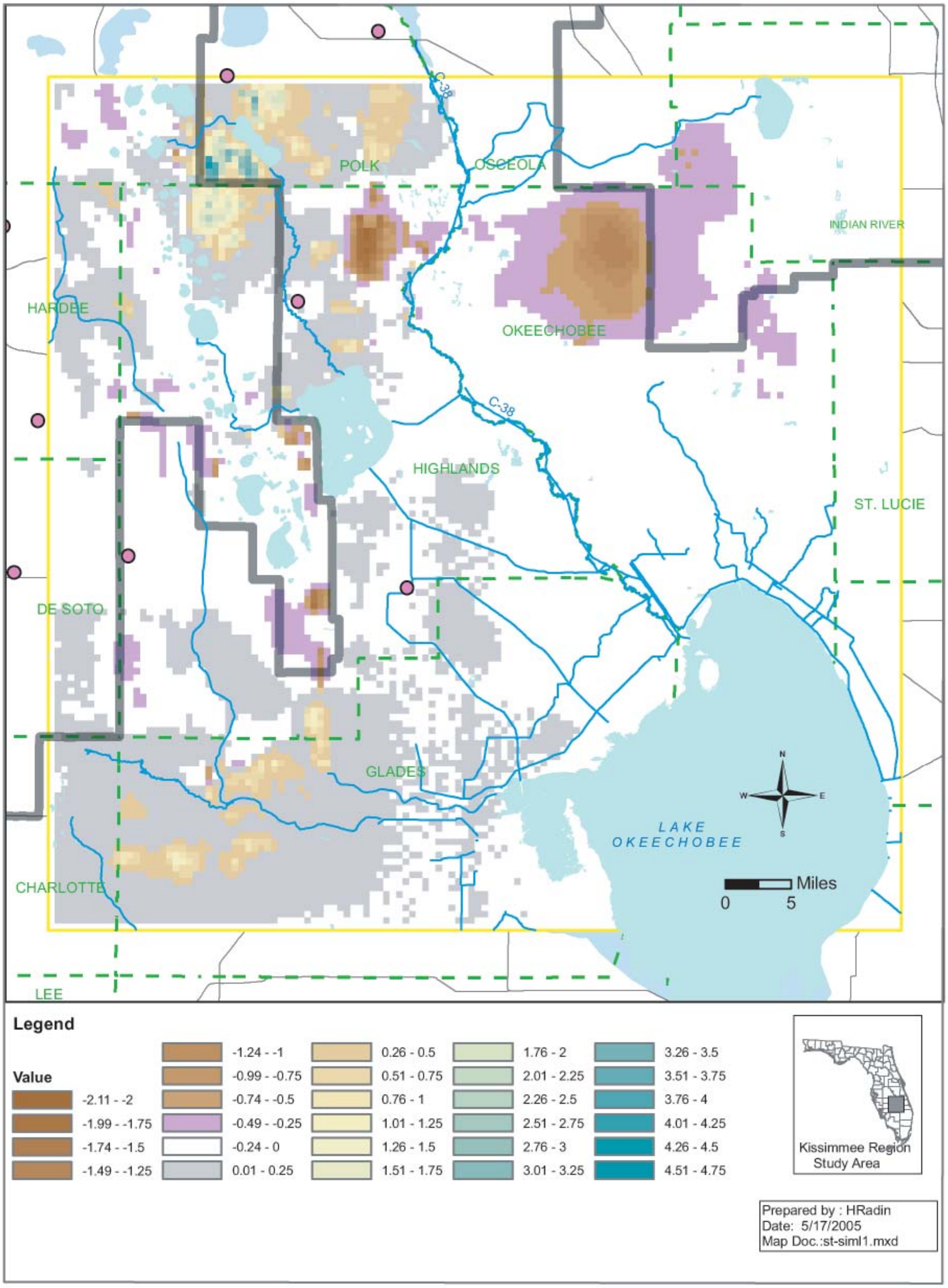

Figure D-57. Drawdown (feet) in Upper Floridan Aquifer – 1995 1-in-10 and 2025 1-in-10 with Wells Off.

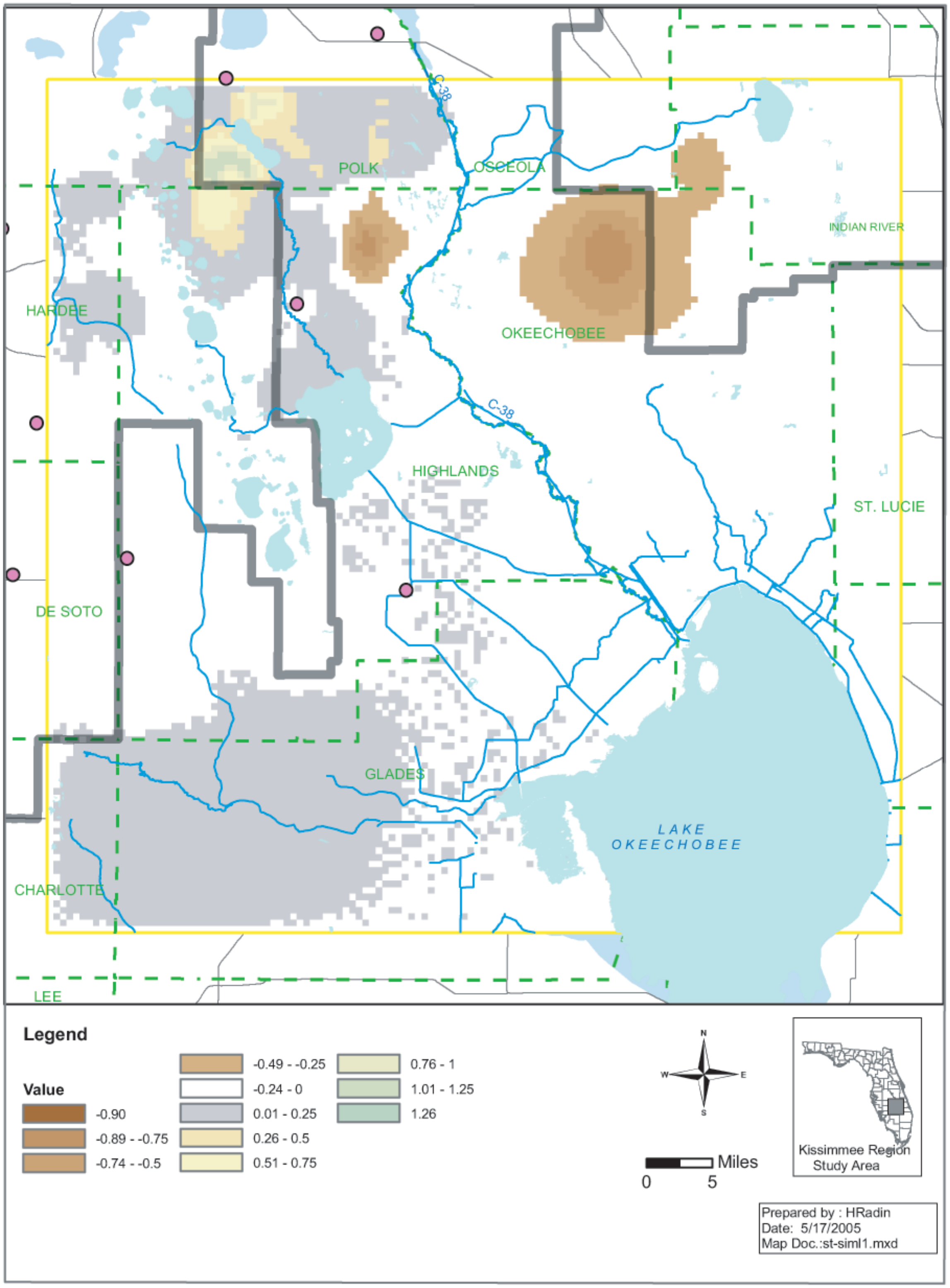

Figure D-58. Drawdown (feet) in Middle Floridan Aquifer – 1995 1-in-10 and 2025 1-in-10 with Wells Off.

MODELING CONCLUSIONS

In general, there is not a significant change (up to 2 feet in most areas) in the water levels simulated with permitted agricultural 1995 demands and the those simulated based on irrigation demands of the crops (AFSIRS).

The Surficial Aquifer is impacted the most by drought conditions.

Consumptive use goes up in 2025. In areas that have landscape irrigation in 2025, where there was no irrigation in 1995, the water levels in 2025 are higher than in 1995. Most of the model area had little change in water levels between the 1995 simulation and the 2025 simulation. In some agricultural areas, the consumption in 2025 is expected to increase, lowering water levels in the Upper Floridan Aquifer by up to 5 feet. The Surficial Aquifer is impacted even more by the changes between 1995 and 2025.

The impacts of the proposed Heartland wells, when placed in the Upper Floridan Aquifer are concentrated in the Upper Floridan Aquifer, with the greatest impacts occurring within a 2-mile radius of the wells. At the wells themselves the drawdowns were 13, 18 and 25 feet respectively for wells G62, G63 and G64. Residual impacts to water levels of the proposed wellfield pumpage are observed in the Upper Floridan simulated layers for up to 10 miles around the wells. The wells had little impact on the Surficial Aquifer System due to presence of the intermediate confining layer in these locations. It is recommended that SWFWMD will review and evaluated wellfield impacts within SWFWMD boundaries. Impacts within the SWFWMD will need to be evaluated by their staff.

When the proposed wells were placed in the Middle Floridan Aquifer, the impacts lessened at the well sites themselves by only being 0.26 feet, 2.41 feet and 1.86 feet respectively for wells G62, G63 and G64 in the Middle Floridan, but they impacted the Upper Floridan too, up to 0.5 feet less drawdown at well site, but similar drawdowns elsewhere. The radius of impact was nearly the same as when wells were placed in Upper Floridan.

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